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Methane Emission From U.S. Coal Mines, A Survey

UNITED STATES DEPARTMENT OF THE INTERIOR

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Methane Emission From U.S. Coal Mines, A Survey

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METHANE EMISSION FROM U.S. COAL MINES, A SURVEY

by

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Maurice Deul,[3] and M. G. Zabetakis[4]

ABSTRACT

This survey was conducted to determine the magnitude of the methane emission and control problem in U.S. bituminous coal mines. The resultant data indicate that the emission rate for any given coalbed depends primarily on the coal production rate and on mine depth, as well as on the nature of the coalbed and the surrounding strata. An excellent correlation was found between (1) the methane emission rate and (2) the product of coal production rate and mine depth for the mines in the Pittsburgh, Pocahontas Nos. 3 and 4, and the Illinois Nos. 5 and 6 coalbeds.

The highest total emission rates found in U.S. bituminous coal mines were as follows, in million cubic feet per day: Monongalia County, W. Va., 39; Marion County, W. Va., 30.4; McDowell County, W. Va., 13.1; Washington County, Pa., 11.9; Greene County, Pa., 11.4; Buchanan County, Va., 21.6; Jefferson County, Ala., 10.3; and Franklin County, Ill., 6.6.

INTRODUCTION

Methane in air has long been a hazard to mine safety because of its explosive qualities, and the Bureau of Mines has engaged in methane studies since its establishment in 1910. One of the earliest studies was actually begun in 1907 under the immediate supervision of Dr. J. A. Holmes, who subsequently became the first director of the Bureau of Mines.[5] That study was made "to obtain information on the origin of the inflammable gases in coal and the conditions under which they occur." Data were obtained from the anthracite fields in Pennsylvania and the southern bituminous fields in Illinois.

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[1]Mining engineer.
[2]Physicist.
[3]Supervisory geologist.
[4]Supervisory research chemist.
[5]Darton, N. H. Occurrence of Explosive Gases in Coal Mines. BuMines Bull. 72, 1915, 248 pp.

The extent to which methane gas emission will be a problem in the future, especially in the underground mining of subbituminous coals and lignites, has not yet been determined. However, the data presented in this report should assist in planning new mine development in the vicinity of operating mines for which methane emission rates are known and in planning effective methane control procedures.

ACKNOWLEDGMENTS

The authors express their appreciation to the district and subdistrict managers, supervisors, and inspectors of the Coal Mine Health and Safety branch of the Federal Bureau of Mines, who willingly contributed their time and experience. The successful completion of this study would not have been possible without their cooperation. Further, special credit is due Miss Rose Marie Como, who collected and tabulated information from Federal mine inspection reports, and to Mr. James L. Joyce, who checked the tabulated data and prepared many of the graphs included here.

DESCRIPTION OF U.S. COALBEDS

Geographical Distribution

Geographically, coal is found in the conterminous United States bordering the Atlantic and Pacific Oceans, the Gulf of Mexico, Mexico, and the Dominion of Canada; it is found in the mountain provinces, the Coastal Plains, and the northern Great Plains. Although coal mining is commonly known to be a major industry only in Appalachia and the coal basins of Illinois-Indiana, coal is now being mined in 24 of the 34 conterminous States which have significant coal resources.

According to Averitt,[6] coal-bearing rocks underlie about 14 percent of the land area of the 48 conterminous States. Figure 1, familiar to most persons concerned with coal resources, shows the geographic distribution of U.S. coalfields. However, it is more useful to examine this map in conjunction with figure 2, also from Averitt,[7] which shows the distribution of the remaining coal resources in the various States.

Coal Resources and Methane Emission

All coalbeds contain methane. This gas is formed from plant materials by biochemical and bacterial transformations during the peat stage of coal deposition and subsequently by metamorphic processes as buried peat increases in rank to become coal. Because of the fine pore structure of coal and degraded peat, the sorptive capacity of such substances is very large so that much of the methane evolved during coalification is held in the peat and in the coal. The actual amount of methane retained in the coal depends also

[6]Averitt, Paul. Coal Resources of the United States January 1, 1967. U.S. Geol. Survey Bull. 1275, 1969, 116 pp.
[7]Work cited in footnote 6.

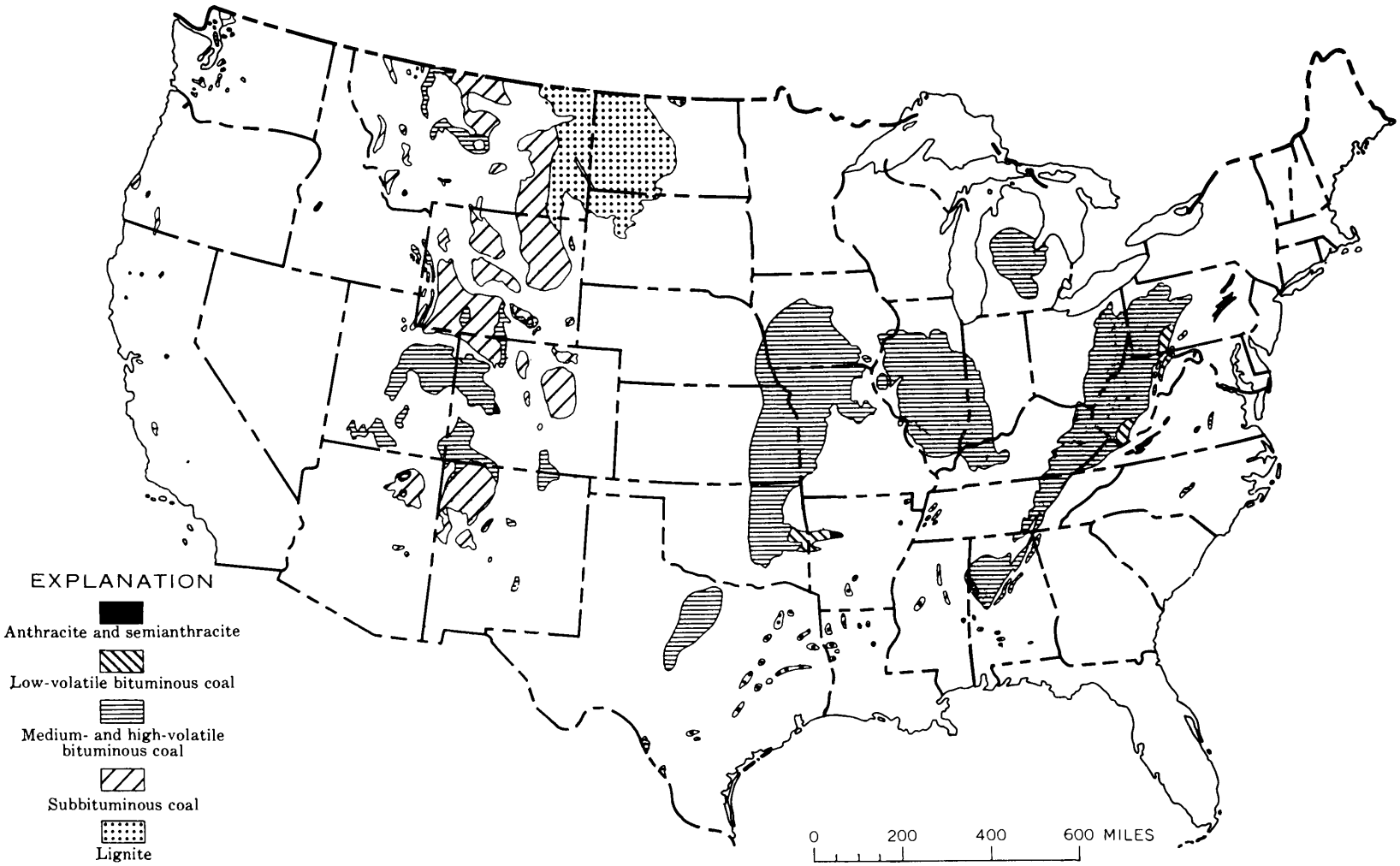

FIGURE 1. - Coalfields of the Conterminous United States.

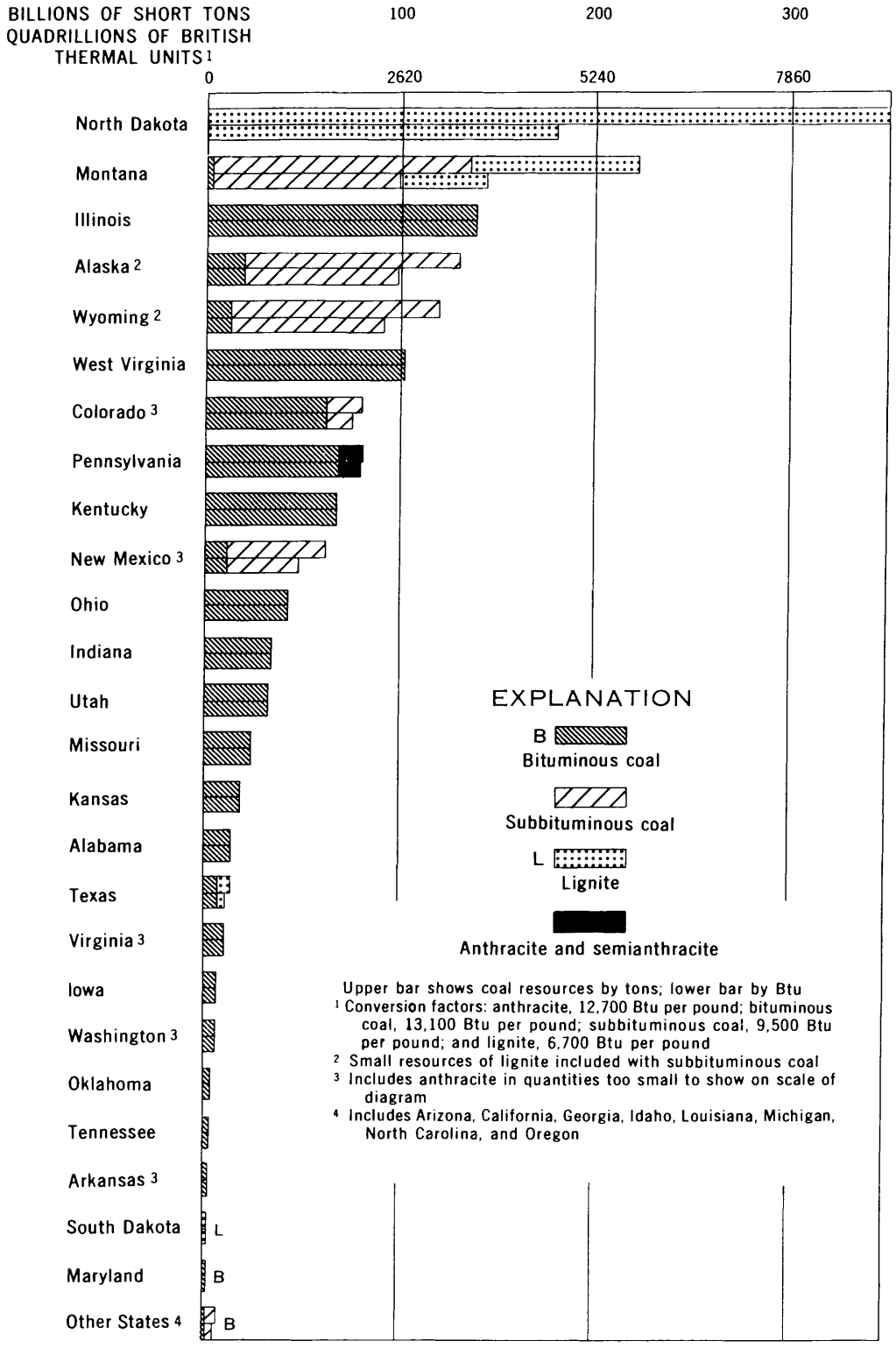

FIGURE 2. - Remaining Coal Resources of the United States as Determined by Mapping and Exploration, January 1, 1967, by State, According to Tonnage and Heat Value.

on the depth of overburden, the hydrostatic head, and the location of faults and free surfaces. When a coalbed is mined and the equilibrium conditions change, methane will migrate from the coalbed into the active mine workings.

As of January 1, 1967, coal resources of the United States (excluding Hawaii) with less than 3,000 feet of overburden, as determined by mapping and exploration, totaled about 1.56×10^{12} short tons.[8] A more recent survey estimated resources of strippable coal and lignite in the United States to be 2.21×10^{11} tons of coal as of January 1, 1968.[9] These data can be used to estimate the magnitude of the resources of nonstrippable coal--the coal that can be expected to contain significant amounts of methane that must be either diluted to safe and manageable concentrations in the mine air or otherwise must be removed from the coalbed and the mine environment. Thus, the coal resources in a zone less than 3,000 feet below the surface that must be considered as potentially minable by underground methods are about 1.3×10^{12} tons.

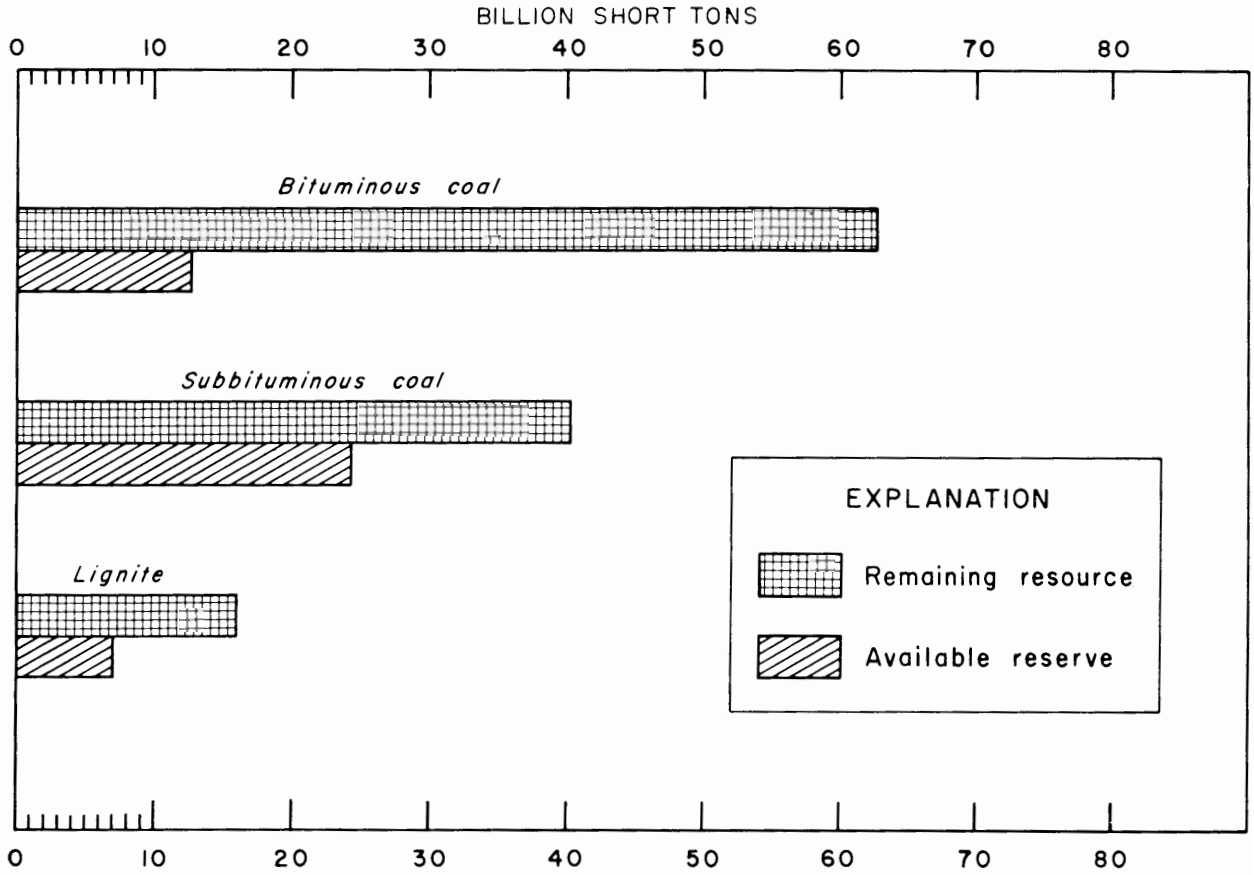

FIGURE 3. - Total Remaining Strippable Resources and Reserves of Coal and Lignite in the United States, by Rank, as of January 1, 1968.

[8]Work cited in footnote 6.

[9]U.S. Bureau of Mines. Strippable Reserves of Bituminous Coal and Lignite in the United States. BuMines Inf. Circ. 8531, 1971, 148 pp.

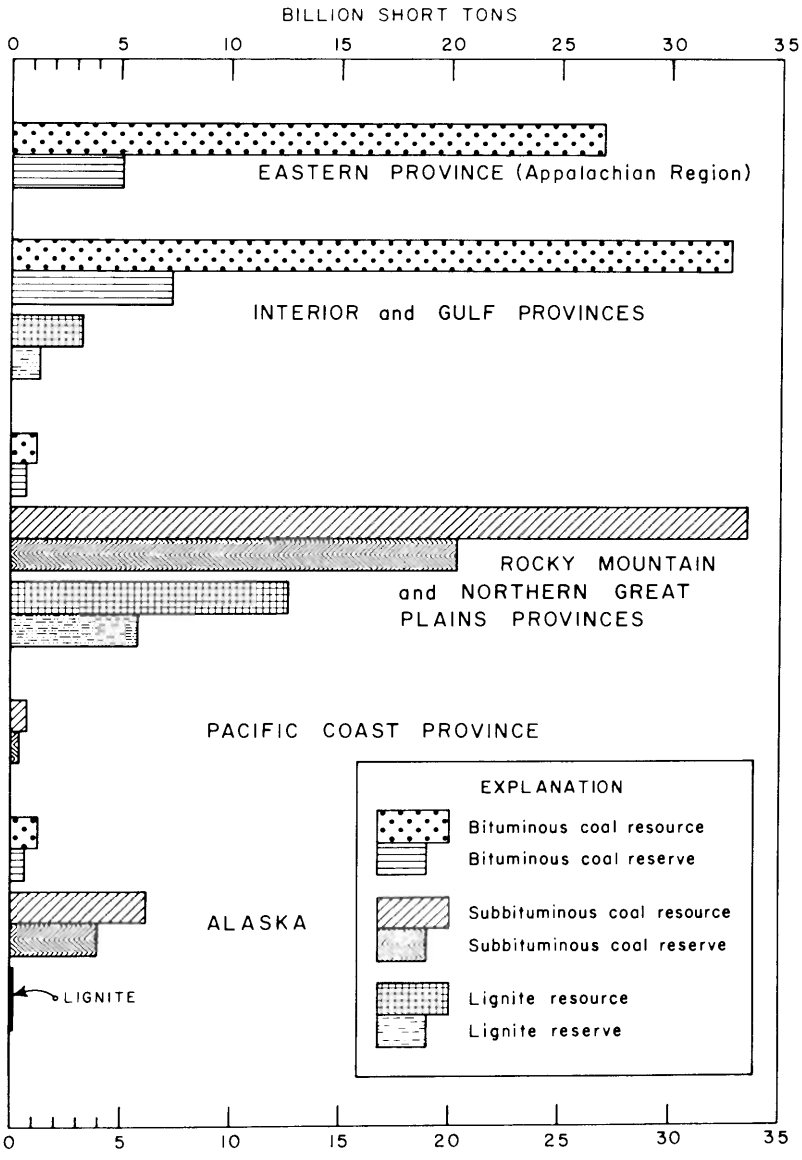

FIGURE 4. - Remaining Strippable Resources and Reserves of Coal and Lignite in the United States, by Coal Province, as of January 1, 1968.

If resources in unmapped and unexplored areas are to be considered, 1.3×10^{12} tons may be added. For the purposes of this report, coalbeds deeper than 3,000 feet are not considered.

An examination of figures 3 and 4[10] shows the resources and reserves of strippable coal in the United States in total and by coal province. The extent to which methane gas emission will be a problem, especially in the underground mining of subbituminous coals and lignites, has not yet been determined. But certainly these kinds of studies will indicate the direction that future research efforts should take.

Relationship to Oil and Gas Deposits

Because coalbeds and coal-bearing rocks underlie a significant percentage of the land area of the United States, and because such areas also represent major basins of sedimentary deposits, it is not at all surprising to find strata containing oil and gas deposits below and sometimes above coal-bearing rocks. The areal relationships among oil, gas, and coal deposits are dramatically shown in the multicolored maps of The National Atlas.[11] This close proximity is often a problem in exploiting coal resources when gas and/or oil well casings penetrate coalbeds that are being mined--or that will be mined--because large pillars of coal must be left to protect the casing from rupturing. Furthermore, some potential subsurface gas storage areas for pumped gas may be subject to interference

[10] Work cited in footnote 9.

[11] U.S. Geological Survey. The National Atlas of the United States of America. 1970, 417 pp.

by future coal mining operations. Consequently, the optimal development of the fossil energy resources of this Nation depends upon evaluation of the interactions induced by the exploitation of our coal, oil, and gas deposits.

DATA SOURCES

Most of the data included in this report were obtained from Federal inspection reports for 1971, interviews with mine officials, interviews with Federal mine inspectors, back files of coal companies, and charts from recording methanometers installed by the Federal Bureau of Mines at a few selected mines. Information also was collected from published and unpublished reports of the Bureau of Mines and from other pertinent publications.

PRESENTATION OF DATA

The summaries and correlations of data obtained in this study are presented in tabular, graphic, and equation form. The most complete set of data is given in appendix 1, which contains a list of 66 bituminous coal mines that produce at least 1 million cubic feet of methane per day. Included in this compilation are the identification and thickness of the coalbed, methane emission and coal production rates, ventilation rate, number of drifts, shafts, and slopes used for ventilation purposes, shaft depth, and age of mine. In addition, because it has been used as a measure of gassiness, the ratio of methane emission to coal production rate is included here (col. 5); note, however, that this ratio is invariably higher than the actual gas content of a ton of coal in place, for methane enters the ventilating air from the adjacent strata and the unmined coal as well as from that which is mined. Methane continues to be emitted indefinitely after all mining ceases. For example, figure 5 shows the effect of a strike-induced idle period on a mine in Pennsylvania during 1971. The methane emission rate dropped from a high of 1 million cubic feet per day before the strike to a low of 0.7 million cubic feet per day during the strike. Following this idle period, the methane emission rate rose steadily and reached its prestrike value within about 4 weeks.

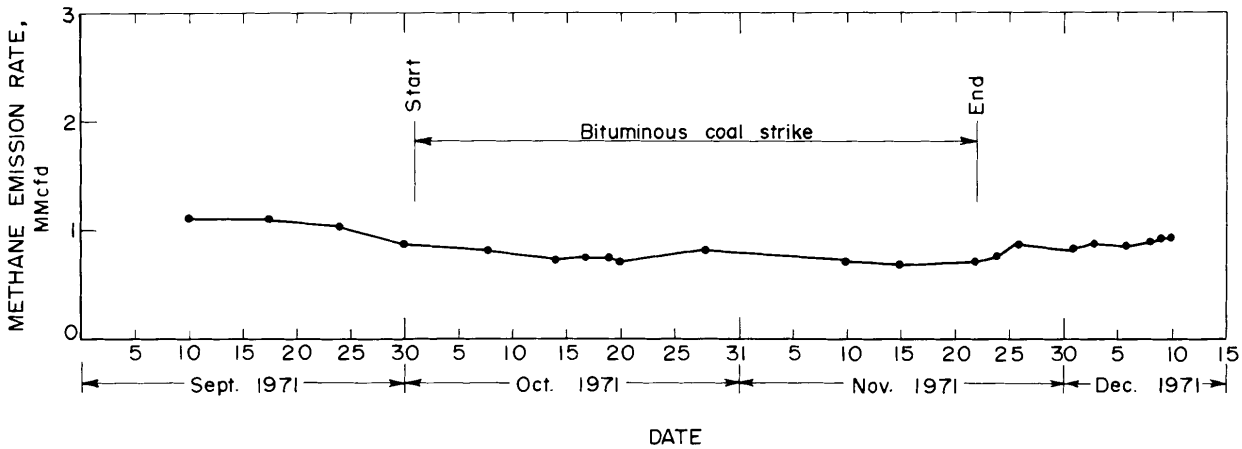

FIGURE 5. - Effect of an Idle Period on the Methane Emission Rate of an Operating Mine in Pennsylvania.

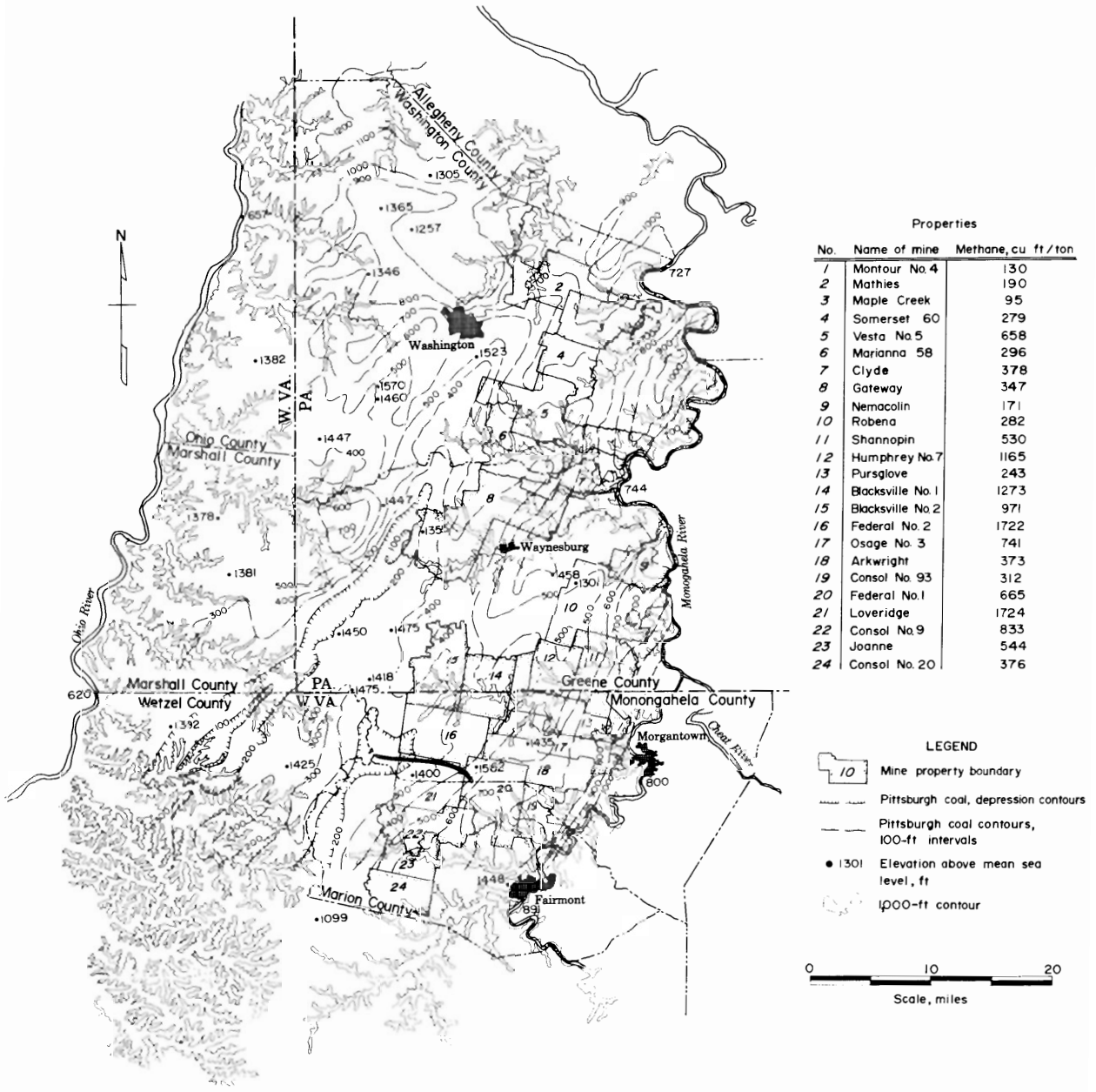

FIGURE 6. - Locations of Active Mines in the Pittsburgh Coalbed.

Methane emission rate data are useful in planning a new mine in the vicinity of an operating mine for which such rates are known. For example, figure 6 shows coal contours, surface elevations, and the locations of a number of active mines in the Pittsburgh coalbed. These mines are identified in the appendixes, which also contain the current methane emission figures for each mine. Note in particular the increase in methane emission rate as one goes southwest away from the Monongahela River towards deeper cover; this factor is considered in detail in the next section.

A list of 199 mines that emit 0.1 to 12.2 million cubic feet of methane per day is given in appendix 2 in order of decreasing emission rate. As noted in this appendix, these mines liberate a total of 227 million cubic feet of methane per day.

Appendix 3 presents data on the counties with a methane emission rate in excess of 100,000 cubic feet per day. Appendix 4 is a similar compilation by coalbed; included here are beds with methane emission rates in excess of 1 million cubic feet per day.

RESULTS AND DISCUSSION

An analysis of the data in appendix 1 indicates the methane emission rate depends primarily on the depth of the mine and the coal production rate. This is illustrated by the charts given in figures 7 and 8, which show the positive trends between these variables for mines in the Illinois Nos. 5 and 6 coalbeds;

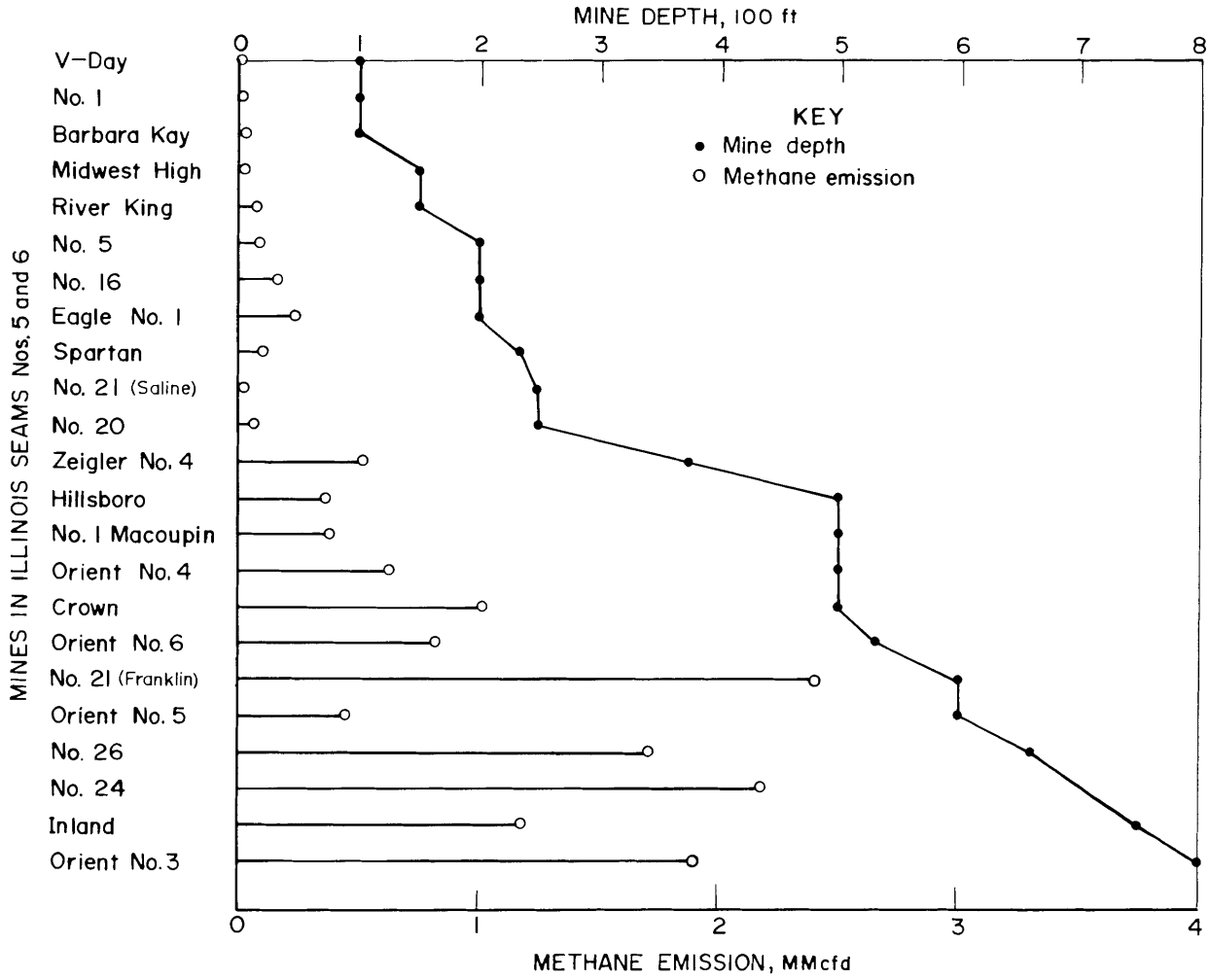

FIGURE 7. - Methane Emission Rate and Average Depth of Mines in the Illinois Nos. 5 and 6 Coalbeds.

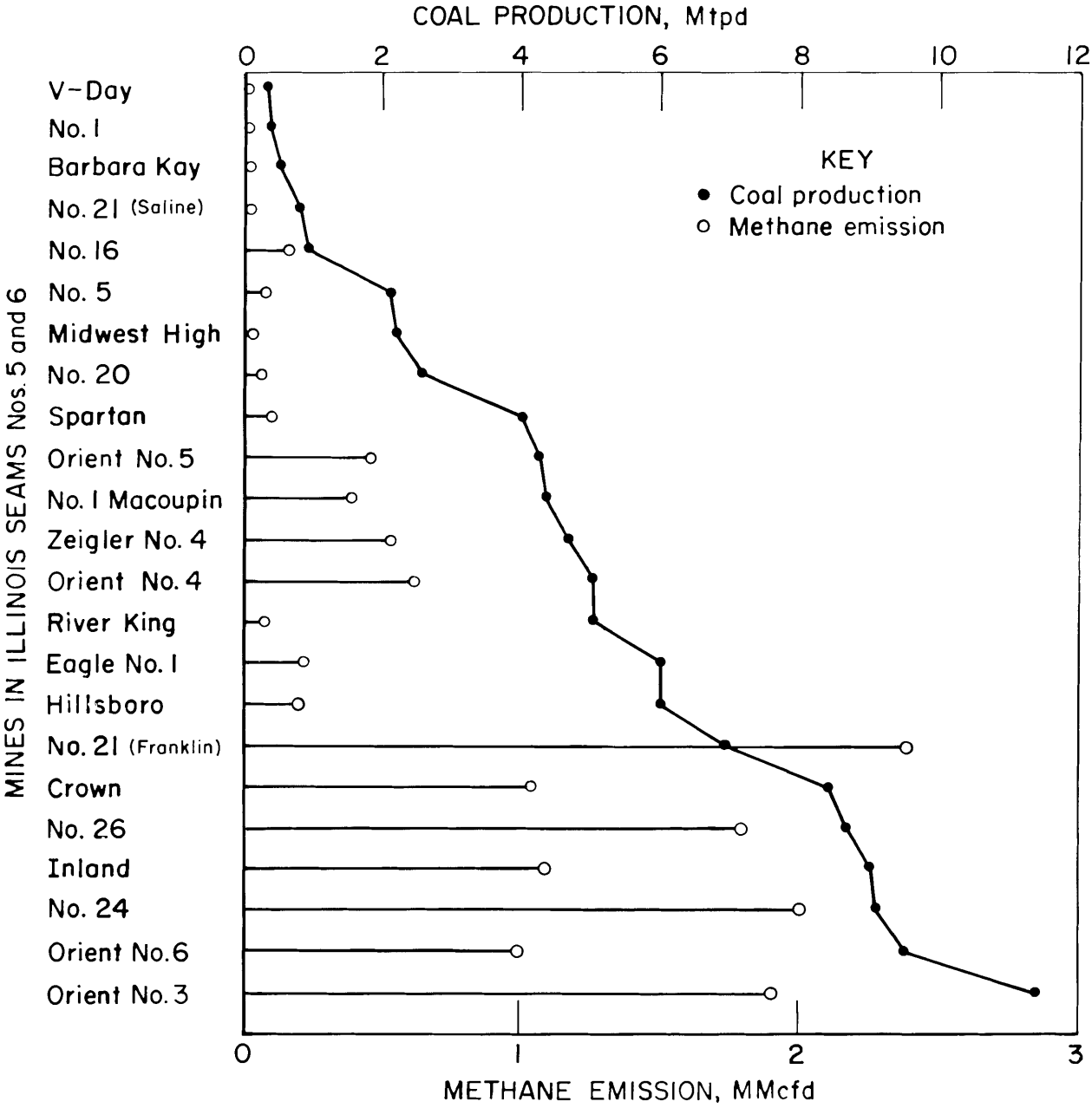

FIGURE 8. - Methane Emission and Coal Production Rates of Mines in the Illinois Nos. 5 and 6 Coalbeds.

Darton[12] noted the existence of a similar trend between depth and the amount of methane released per ton of coal mined in southern Illinois. On the other hand, there appears to be very little correlation between methane emission and the age (or size) of the mine (fig. 9). Combining these observations, we find an excellent correlation between (1) the methane emission rate (MER) in

[12]Page 223 of work cited in footnote 5.

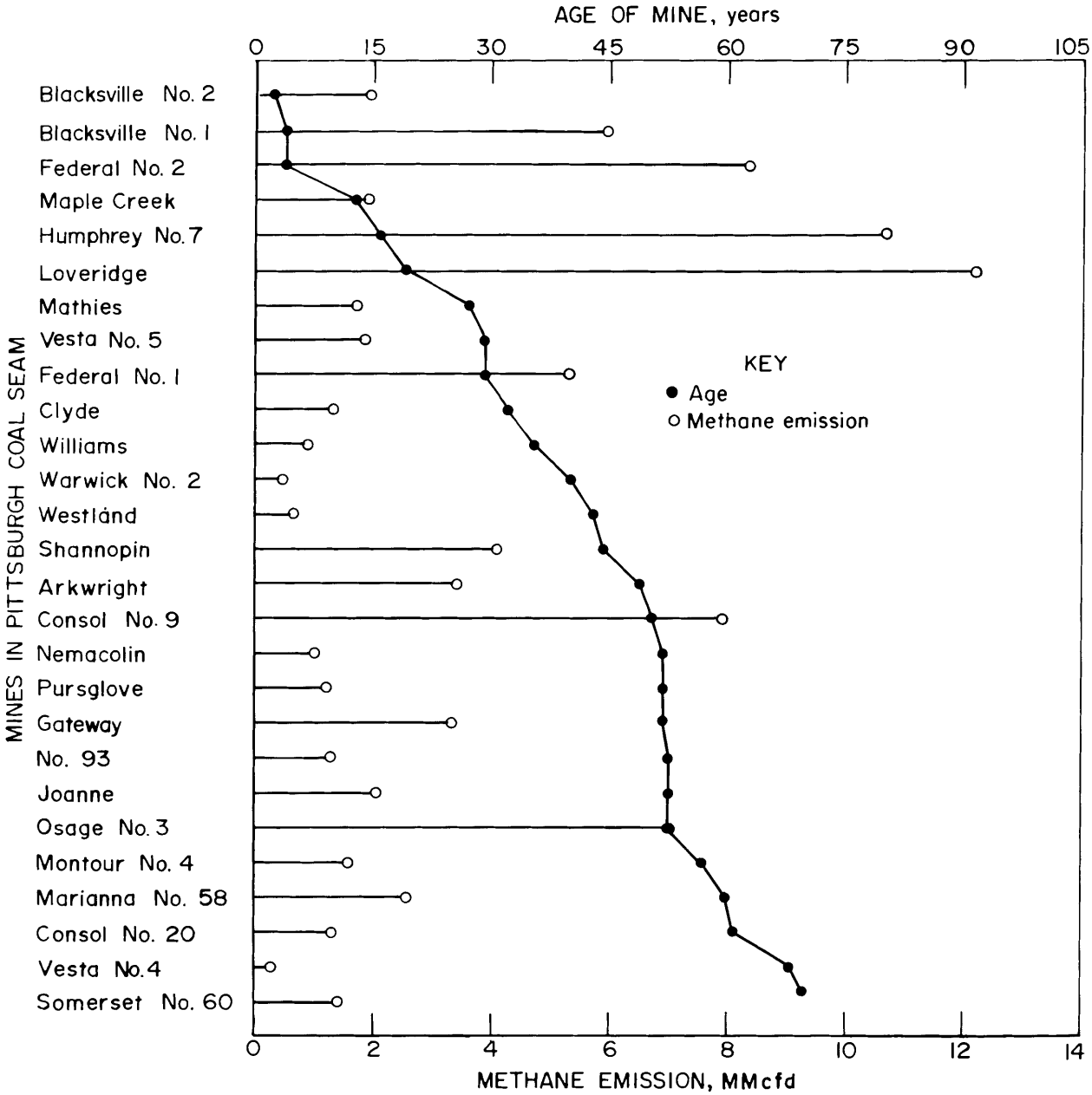

FIGURE 9. - Methane Emission Rate and Age of Mines in the Pittsburgh Coalbed.

millions of cubic feet per day and (2) the product of coal production rate (CPR) in thousands of tons per day and depth (D) in thousands of feet for the mines in the Pittsburgh (Pgh), Pocahontas Nos. 3 and 4 (Poc), and the Illinois Nos. 5 and 6 (Ill) coalbeds (figs. 10-12). The equations for determining methane emission rate are as follows, in millions of cubic feet per day:

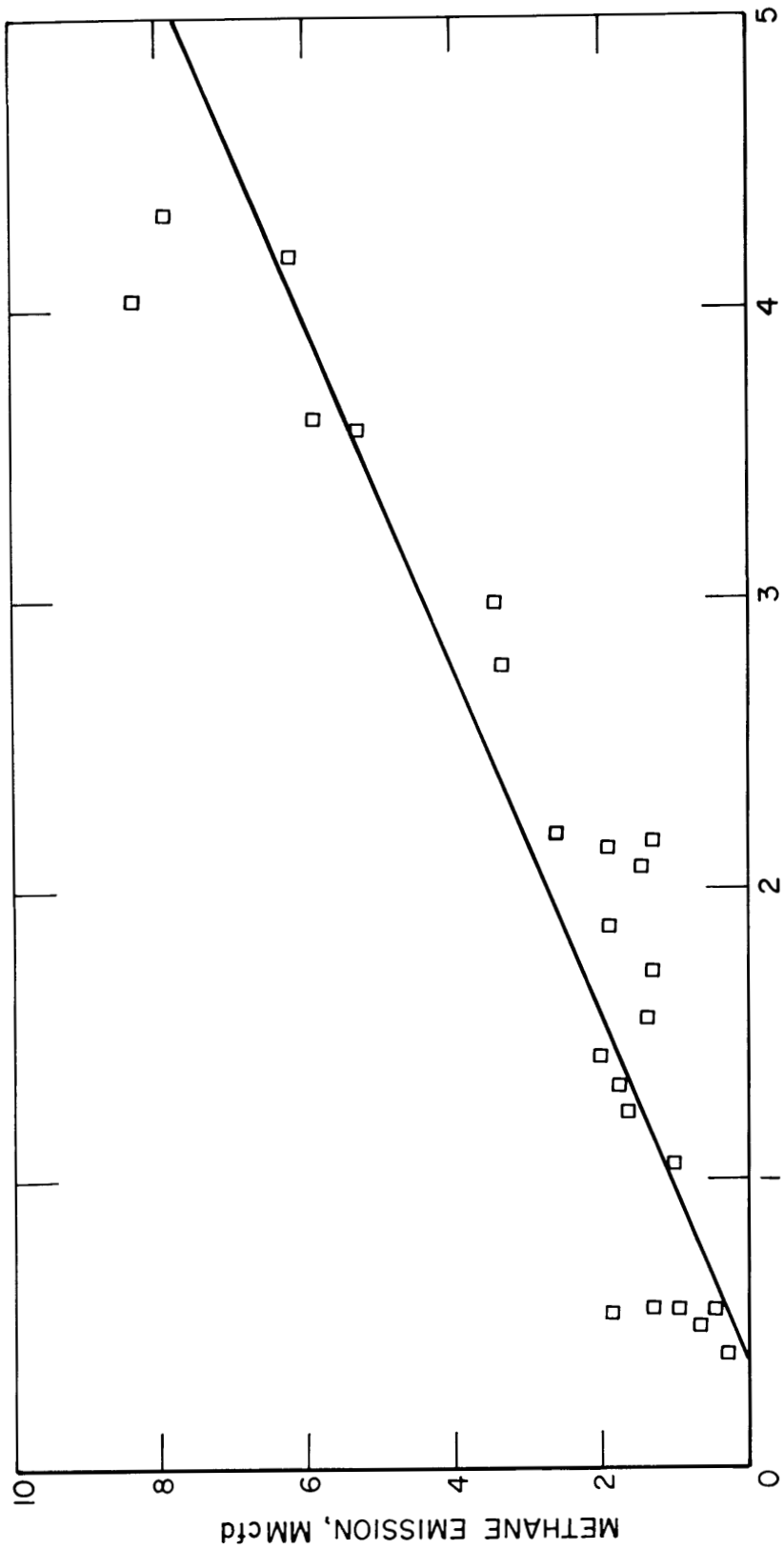

FIGURE 10. - Methane Emission Rate Versus Coal Production Rate Times Depth for Mines in the Pittsburgh Coalbed.

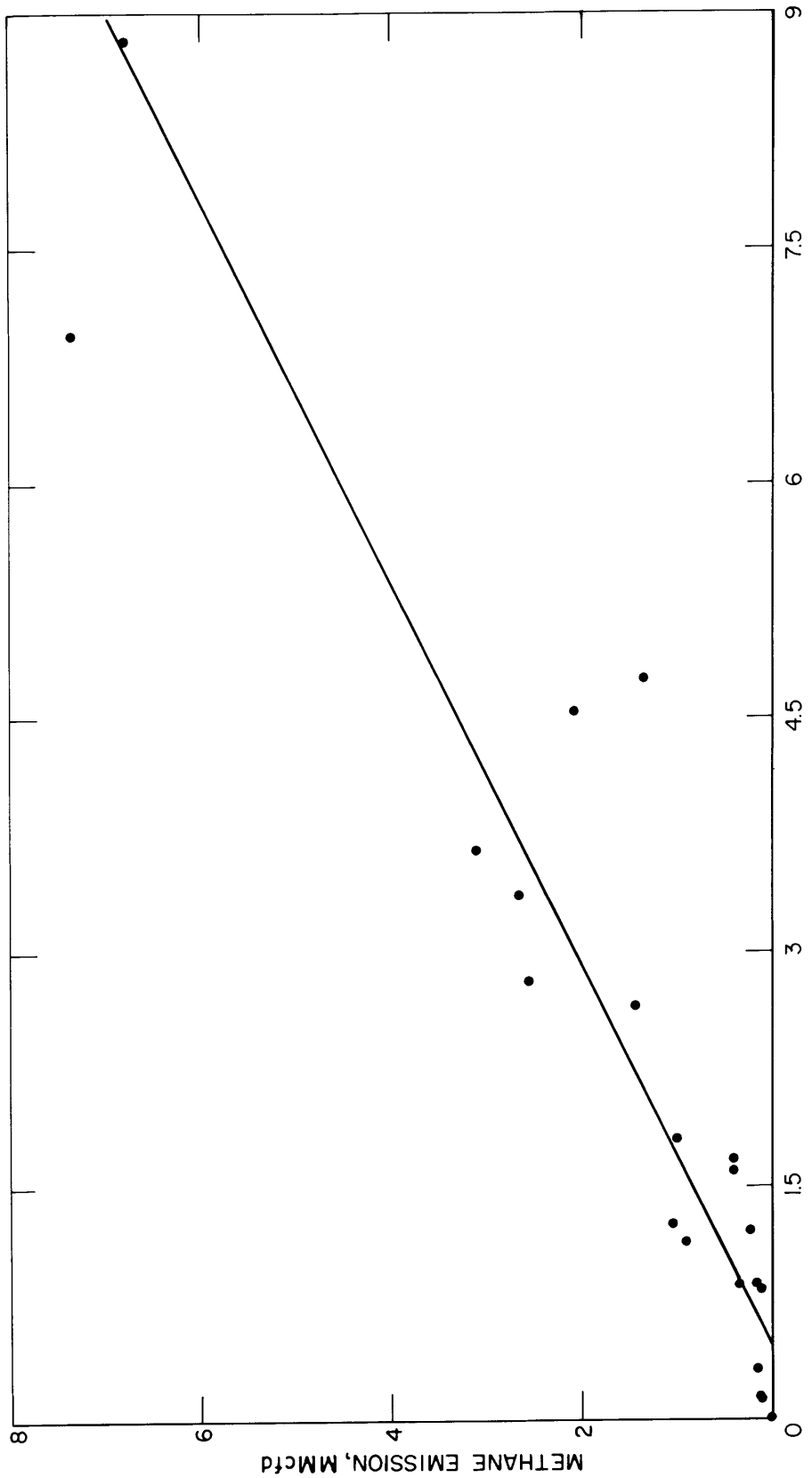

FIGURE 11. - Methane Emission Rate Versus Coal Production Rate Times Depth for Mines in the Pocahontas Nos. 3 and 4 Coalbeds.

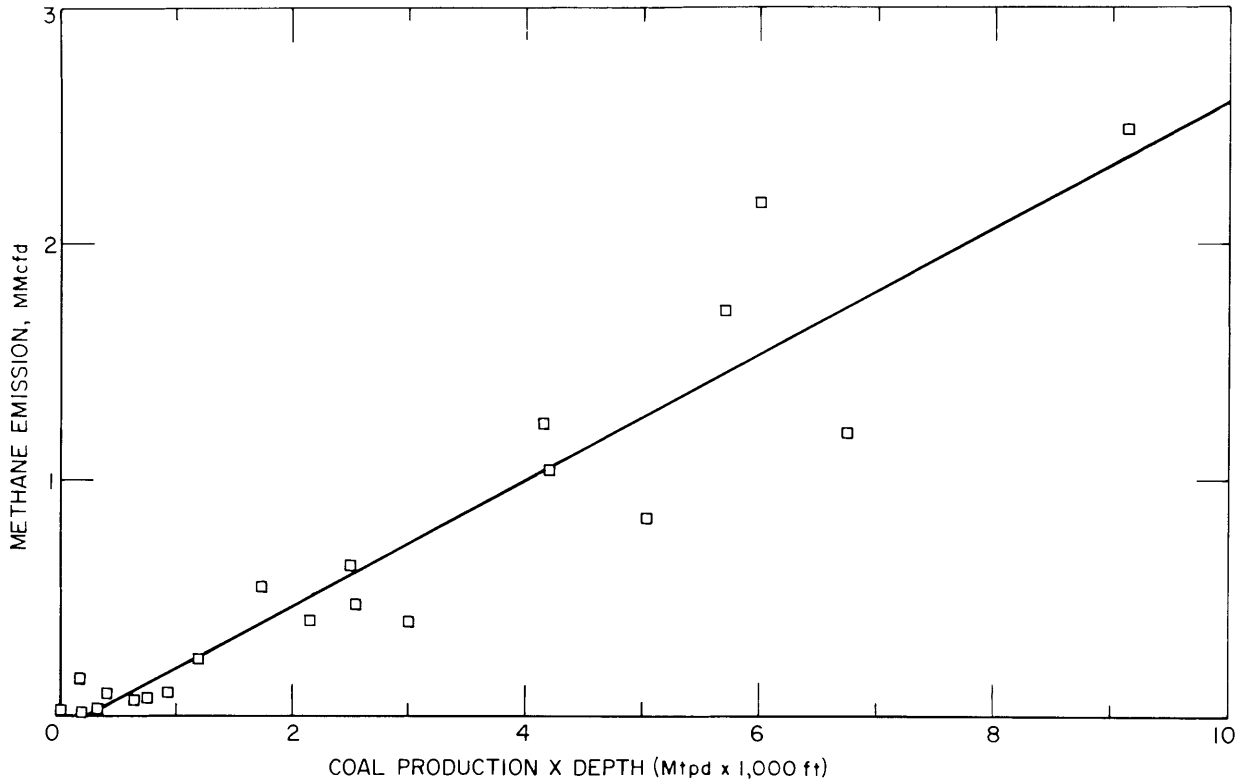

FIGURE 12. - Methane Emission Rate Versus Coal Production Rate Times Depth for Mines in the Illinois Nos. 5 and 6 Coalbeds.

$$MER\ (Pgh) = -0.649 + 1.67 \times CPR \times D; \quad 5 \geq CPR \times D \geq 0.388 \qquad (1)$$

$$MER\ (Poc) = -0.395 + 0.80 \times CPR \times D; \quad 9 \geq CPR \times D \geq 0.494 \qquad (2)$$

$$MER\ (Ill) = -0.071 + 0.268 \times CPR \times D; \quad 10 \geq CPR \times D \geq 0.265 \qquad (3)$$

The correlation coefficients are 0.91, 0.92, and 0.94 for the Pittsburgh, Pocahontas, and Illinois coalbeds, respectively, so that the product of coal production rate and depth accounts for over 80 percent of the variability in the methane emission rates for each of these coalbeds. Obviously, the methane emission rate also is affected by the presence of gobs, faults, nearby mining operations, clay veins, and oil and gas wells.

Note that the equations can be used to predict not only methane emission rates but also the ratios of such rates for the three coalbeds at a given depth. Thus, with a production rate of 5,000 tons per day and a depth of 1,000 feet, the ratio of the methane emission rates for the Pittsburgh and Pocahontas beds is 2.14, for the Pocahontas and Illinois beds 2.84, and for the Pittsburgh and Illinois beds 6.06; this means that the emission rate of the Pittsburgh bed is greater than that of the Pocahontas beds which, in turn, have an emission rate greater than the Illinois coalbeds. These ratios may seem out of line in view of the fact that the quantity of methane adsorbed by coal at any given pressure (or depth) is greatest for the Illinois coalbed.

However, we can only conclude that at least for the Pittsburgh coalbed, methane emission rates are dependent on the permeability of the coalbed itself and on the gas content and permeability of the adjacent strata.

Of the total methane emitted by the bituminous coal mines in the conterminous United States, approximately two-thirds (65.8 percent) is emitted by the mines in the Pittsburgh (44.5 percent), Pocahontas No. 3 (14.7 percent), and the Illinois Nos. 5 and 6 (6.6 percent) coalbeds. The remainder (34.2 percent) is emitted by the mines in the other coalbeds. Interestingly, over three-fourths (78.9 percent) of the methane emitted by the mines in the conterminous United States is emitted by those with emission rates of 1 million cubic feet or more per day; 28 mines in this group emit 92.8 percent of all the methane from the Pittsburgh coalbed (appendix 1).

The 199 mines listed in appendix 2 emit 227.0 million cubic feet of methane per day. An analysis of data from 231 mines with measurable methane liberation rates (but less than 100,000 cubic feet per day) indicates that these emit only 4.7 million cubic feet of methane per day. Of the mines in the former category, those in West Virginia liberate 46.6 percent, those in Pennsylvania, 19.2 percent, those in Illinois, 6.7 percent, and those in Alabama, 5.1 percent of the total (appendix 3). Further, the mines in Monongalia County, W. Va., emit the largest total volume of methane recorded for any county--39 million cubic feet per day; mines in Marion County, W. Va., emit 30.4, and those in McDowell County, W. Va., emit 13.1 million cubic feet of methane per day. In Pennsylvania, the mines in Washington County emit 11.9 and those in Greene County, 11.4 million cubic feet of methane per day. In Virginia the mines in Buchanan County emit 21.6 million cubic feet, while those in Jefferson County, Ala., emit 10.3 and those in Franklin County, Ill., emit 6.6 million cubic feet of methane per day (appendix 4).

CONCLUSIONS

Methane emission rate data can be readily compiled from available reports. In turn, these data can be correlated with the coal production rate and depth for any particular coalbed. A linear correlation holds for the Pittsburgh, Pocahontas Nos. 3 and 4, and Illinois Nos. 5 and 6 coalbeds. The correlations obtained to date can be used to predict the methane emission rate and subsequently assist in planning effective methane control procedures in bituminous coal mines.

APPENDIX 1.--CHARACTERISTICS OF U.S. COAL MINES PRODUCING OVER 1 MILLION CUBIC FEET OF METHANE PER DAY

Owner, name of mine, and location	Coalbed	Thickness of coalbed, in	Average methane emission in 24 hr, million cu ft	Daily coal production, tons	Cu ft of gas per ton of coal mined	Quantity of air circulated in 24 hr, million cu ft	Number of drifts (Dr), shafts (Sh), and slopes (Sl)	Average depth of shaft[1] and slope,[2] ft	Age of mine, yr
Allied Chemical Corp.: Shannon Branch mine McDowell County, W. Va.	Pocahontas Nos. 3 and 4.	38-52	2.1	3,800	547	2,847	1 Sl 7 Sh	- 700	64
Bethlehem Mines Corp.: No. 32 mine Cambria County, Pa.	Lower Kittanning	60	6.0	3,000	1,989	854	6 Sh	656 (358-955)	55
Marianna No. 58 mine Washington County, Pa.	Pittsburgh.....	60	2.3	7,362	296	885	9 Sh	399 (385-413)	60
Cambria Slope 33 mine Cambria County, Pa.	Lower Kittanning	42	1.9	4,530	416	772	1 Sl 4 Sh	- 753 (650-857)	8
Somerset No. 60 mine Washington County, Pa.	Pittsburgh.....	48	1.5	5,217	279	962	1 Sl 6 Sh	- 605 (450-760)	67
Bishop Coal Co.: Bishop mine McDowell County, W. Va.	Pocahontas Nos. 3, 4, and 5.	48-60	1.0	6,800	150	914	10 Dr 3 Sh	- 700	42
Boone County Coal Co.: No. 1 Cedar Grove mine Logan County, W. Va.	Cedar Grove.....	48	1.2	1,552	761	474	1 Sl 1 Sh	- 500	3
The Buckeye Coal Co.: Nemacolin mine Greene County, Pa. (mine on fire).	Pittsburgh.....	50	1.0	5,846	171	1,344	1 Sl 5 Sh	- 466 (445-488)	53
Clinchfield Coal Co.: Moss No. 2 mine Russell County, Va.	Tiller.....	60	1.8	4,250	423	733	1 Sl 3 Sh	- 650 (100-1,200)	57

Moss No. 3 mine (Portal A) Dickenson County, Va.	...do.....	84-180	1.4	3,300	410	949	3 Dr 1 Sh	- (626-817)	13
Consolidation Coal Co. (Blacksville Div.): Blacksville No. 1 mine Monongalia County, W. Va.	Pittsburgh.....	78	6.0	4,725	1,273	1,043	4 Sh	725 (650-800)	4
Blacksville No. 2 mine Monongalia County, W. Va.	...do.....	78	2.5	3,400	971	791	2 Sh	713 (711-716)	2
Consolidation Coal Co. (Christopher Coal Co.): Humphrey No. 7 mine Monongalia County, W. Va.	...do.....	90	10.7	9,200	1,165	2,034	1 Dr 6 Sh	- 446 (325-568)	16
Osage No. 3 mine Monongalia County, W. Va.	...do.....	96	7.0	9,400	741	1,630	1 Dr 4 Sh	- 441 (260-623)	55
Arkwright mine Monongalia County, W. Va.	...do.....	84	3.4	9,166	373	1,011	5 Sh	332	49
Pursglove mine Monongalia County, W. Va.	...do.....	96	1.3	5,166	243	583	2 Sl 5 Sh	- 394 (292-496)	53
Consolidation Coal Co. (Mountaineer Coal Co.): Loveridge mine Marion County, W. Va.	...do.....	96	12.2	7,062	1,724	2,527	1 Sl 5 Sh	- 721	20
Consol No. 9 mine Marion County, W. Va.	...do.....	96	8.0	9,500	833	-	7 Sh	456	50
		(Mine explosion November 1968. Mine being recovered.)							
Williams mine Harrison County, W. Va.	...do.....	96	1.0	5,000	200	918	1 Sl 10 Sh	- 111 (20-202)	-
Consol No. 20 mine Marion County, W. Va.	...do.....	84	1.4	3,700	376	635	7 Sh	398 (267-530)	61

See footnotes at end of table.

Owner, name of mine, and location	Coalbed	Thickness of coalbed, in	Average methane emission in 24 hr, million cu ft	Daily coal production, tons	Cu ft of gas per ton of coal mined	Quantity of air circulated in 24 hr, million cu ft	Number of drifts (Dr), shafts (Sh), and slopes (Sl)	Average depth of shaft[1] and slope,[2] ft	Age of mine, yr
Consolidation Coal Co. (Mountaineer Coal Co.)(Con.):									
No. 93 mine Marion County, W. Va.	Pittsburgh.....	76	1.2	3,800	312	709	2 Dr 2 Sh	- 226 (201-252)	55
Robinson Run No. 95 mine Harrison County, W. Va.	...do.....	72-92	1.1	9,000	127	694	10 Dr 1 Sh	- 300	5
Consolidation Coal Co. (Ohio Valley Div.):									
Ireland Mine Marshall County, W. Va.	Pittsburgh No. 8.	62	1.8	9,666	188	1,630	2 Sl 6 Sh	- 370	16
Consolidation Coal Co. (Pittsburgh Coal Co.):									
Montour No. 4 mine Washington County, Pa.	Pittsburgh.....	52	1.1	8,450	130	958	2 Sl 6 Sh	- 145 (92-198)	58
Eastern Associated Coal Corp.:									
Federal No. 2 mine Monongalia County, W. Va.	...do.....	90	8.1	4,700	1,722	1,331	3 Sh	788 (734-842)	4
Federal No. 1 mine Marion County, W. Va.	...do.....	82	5.1	7,666	665	1,696	8 Sh	448 (260-637)	29
Joanne mine Marion County, W. Va.	...do.....	84	2.0	3,585	544	738	4 Sh	404 (354-455)	55
Keystone No. 1 mine McDowell County, W. Va.	Pocahontas No. 3.	60	1.8	6,500	280	2,001	1 Sl 2 Dr 7 Sh	- - 700	71
Freeman Coal Mining Corp.:									
Orient No. 3 mine Jefferson County, Ill.	Illinois No. 6...	108	1.9	11,277	167	411	2 Sl 3 Sh	- 800	25
Orient No. 6 mine Jefferson County, Ill.	...do.....	108	1.0	8,950	113	844	2 Sh	530	4

Crown mine Montgomery County, Ill.	...do.....	84	1.0	8,400	124	930	2 Sh	500	25
Gateway Coal Co.: Gateway mine Greene County, Pa.	Pittsburgh.....	84	2.6	7,410	347	1,265	2 S1 6 Sh	- 375 (50-700)	53
Glen Nan Coal Co.: Forge Slope mine Luzerne County, Pa.	Twin, Bottom Ross, Bottom Red Ash	60-216	1.5	1,800	816	592	1 S1 3 Sh	- 3,000	-
Helvetia Coal Co. (Rochester and Pittsburgh Coal Co.): Lucerne No. 6 mine Indiana County, Pa.	Upper Freeport...	60	2.0	4,550	428	776	1 S1 1 Sh	636	4
Howe Coal Co.: Howe No. 1 mine Le Flore County, Okla. (Mine closed November 1971).	Lower Hartshorne.	39	1.6	750	2,191	541	2 S1 1 Sh	- 350 (0-700)	5
Inland Steel Co.: Inland mine Jefferson County, Ill.	Illinois No. 6...	108	1.1	8,714	128	500	2 Sh	750	6
Island Creek Coal Co.: Virginia Pocahontas No. 1 mine Buchanan County, Va.	Pocahontas No. 3.	54	6.3	4,950	1,263	1,044	3 Sh	1,162 (1,157-1,167)	5
Virginia Pocahontas No. 3 mine Buchanan County, Va.	...do.....	66	3.1	2,450	1,249	955	3 Sh	1,925 (1,350-2,500)	3
Island Creek Coal Co. (Beatrice Pocahontas Co.): Beatrice mine Buchanan County, Va.	...do.....	54	8.4	4,640	1,812	1,245	4 Sh	1,925 (1,350-2,500)	8
Island Creek Coal Co. (Virginia Pocahontas Co.): Virginia Pocahontas No. 2 mine Buchanan County, Va.	...do.....	48	3.1	2,112	1,473	896	3 Sh	1,925 (1,350-2,500)	4
Itmann Coal Co.: Itmann No. 3 mine Wyoming County, W. Va.	...do.....	48	1.0	3,000	333	628	2 Dr 2 Sh	- 600	12

See footnotes at end of table.

Owner, name of mine, and location	Coalbed	Thickness of coalbed, in	Average methane emission in 24 hr, million cu ft	Daily coal production, tons	Cu ft of gas per ton of coal mined	Quantity of air circulated in 24 hr, million cu ft	Number of drifts (Dr), shafts (Sh), and slopes (Sl)	Average depth of shaft[1] and slope,[2] ft	Age of mine, yr
Jones & Laughlin Steel Corp. (Vesta-Shannopin Coal Div.):									
Shannopin mine Greene County, Pa.	Pittsburgh.....	56	2.9	5,377	530	1,875	10 Dr 5 Sh	- 225 (0-450)	45
Vesta No. 5 mine Washington County, Pa.	...do.....	84	1.9	2,925	658	1,229	1 Sl 7 Dr 6 Sh	- - 250 (0-500)	29
Mathies Coal Co.:									
Mathies mine Washington County, Pa.	...do.....	42	1.8	9,475	190	1,625	1 Dr 7 Sh	- 175 (0-350)	28
Mid-Continent Coal and Coke Co.:									
L. S. Wood mine Pitkin County, Colo.	Basin "B".....	81	3.5	1,125	3,111	592	6 Sl 0 Sh	(0-2,500) -	7
Dutch Creek mine Pitkin County, Colo.	...do.....	81	3.2	1,350	2,359	763	6 Sl 0 Sh	(0-2,500) -	16
North American Coal Co. (Helen Mining Co.):									
Homer City mine Indiana County, Pa.	Upper Freeport...	50	1.6	2,100	766	539	1 Sl 1 Sh	- 608	3
Old Ben Coal Co.:									
No. 21 mine Franklin County, Ill.	Illinois No. 6...	105	2.4	8,000	302	647	3 Sh	600	11
No. 24 mine Franklin County, Ill.	...do.....	100	2.0	9,100	218	537	2 Sh	660	7
No. 26 mine Franklin County, Ill.	...do.....	102	1.8	8,660	202	570	2 Sh	660	4

Olga Coal Co.:									
Olga mine McDowell County, W. Va.	Pocahontas No. 4.	72	2.2	6,000	363	1,730	13 Sh	800	48
Republic Steel Corp.:									
Clyde mine Washington County, Pa.	Pittsburgh.....	50	1.2	3,275	378	232	2 Dr 5 Sh	- 487 (450-525)	33
U.S. Pipe and Foundry Co.:									
Flat Top mine Jefferson County, Ala.	Mary Lee.....	74	1.0	1,703	587	489	2 Sl 6 Sh	- 700	71
Bessie mine Jefferson County, Ala.	...do.....	96	1.1	2,360	478	738	4 Sl 3 Sh	- 530 (380-680)	66
U.S. Steel Corp.:									
Concord No. 1 mine Jefferson County, Ala.	Pratt.....	66-144	6.1	7,200	845	3,813	2 Sl 3 Sh	- 600 (400-800)	25
Robena mine Greene County, Pa.	Pittsburgh.....	84	4.3	15,036	282	3,541	1 Sl 12 Sh	- 556 (445-667)	33
No. 14 mine McDowell County, W. Va.	Pocahontas No. 3.	67	2.5	9,000	280	1,047	16 Dr 2 Sh	- 700	29
Maple Creek mine Washington County, Pa.	Pittsburgh.....	60	1.1	11,605	95	1,338	3 Dr 1 Sl 5 Sh	- - 230	14
Sunnyside No. 1 mine Carbon County, Utah.	Upper Sunnyside.. Lower Sunnyside..	54-66 66-127	1.2	6,000	196	867	1 Dr 2 Sl 7 Sh	- - 1,250 (500-2,000)	74
No. 2 mine McDowell County, W. Va.	Pocahontas No. 4.	84	2.1	9,118	228	1,624	11 Dr 6 Sh	- 700	66
Valley Camp Coal Co.:									
Valley Camp No. 3 mine Ohio County, W. Va.	Pittsburgh No. 8.	63	1.3	4,533	282	728	1 Sl 4 Sh	- 471 (350-463-600)	54

See footnotes at end of table.

Owner, name of mine, and location	Coalbed	Thickness of coalbed, in	Average methane emission in 24 hr, million cu ft	Daily coal production, tons	Cu ft of gas per ton of coal mined	Quantity of air circulated in 24 hr, million cu ft	Number of drifts (Dr), shafts (Sh), and slopes (Sl)	Average depth of shaft[1] and slope,[2] ft	Age of mine, yr
Westmoreland Coal Co.:									
Hampton No. 3 mine Boone County, W. Va.	Cedar Grove.....	42-90	1.6	2,891	554	425	1 Dr 3 Sl 3 Sh	- - 	17
Winding Gulf Coals, Inc.:									
East Gulf mine Raleigh County, W. Va.	Pocahontas No. 3.	65	1.0	2,416	413	342	1 Dr 3 Sl 3 Sh	- - 500	29
Woodward Co. (Div. of Mead Corp.):									
Mulga mine Jefferson County, Ala.	Pratt.....	70	1.5	6,133	249	1,408	5 Sl 8 Sh	- 425 (300-550)	71
Youghiogheny and Ohio Coal Co.:									
Nelms No. 1 mine Harrison County, Ohio.	No. 6A.....	36-120	1.7	4,400	386	379	4 Sh	450	41
Nelms No. 2 mine Harrison County, Ohio.	Lower Freeport...	60	1.3	3,000	434	386	1 Sl 2 Sh	- 400	11

[1]Items in parentheses indicate range of shaft depth.
[2]Items in parentheses indicate range of slope depth.

APPENDIX 2.--MEASURED METHANE EMISSION FROM COAL MINES OF THE UNITED STATES WITH AN EMISSION RATE OF AT LEAST 100,000 CUBIC FEET PER DAY

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Loveridge mine Consolidation Coal Co. Marion County, W. Va.	12.2
Humphrey No. 7 mine Consolidation Coal Co. Monongalia County, W. Va.	10.7
Beatrice mine Island Creek Coal Co. Buchanan County, Va.	8.4
Federal No. 2 mine Eastern Associated Coal Corp. Monongalia County, W. Va.	8.1
Consol No. 9 mine Consolidation Coal Co. Marion County, W. Va.	8.0
Osage No. 3 mine Consolidation Coal Co. Monongalia County, W. Va.	7.0
Virginia Pocahontas No. 1 mine Island Creek Coal Co. Buchanan County, Va.	6.3
Concord No. 1 mine U.S. Steel Corp. Jefferson County, Ala.	6.1
No. 32 mine Bethlehem Mines Corp. Cambria County, Pa.	6.0
Blacksville No. 1 mine Consolidation Coal Co. Monongalia County, W. Va.	6.0
Federal No. 1 mine Eastern Associated Coal Corp. Marion County, W. Va.	5.1

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Robena mine U.S. Steel Corp. Greene County, Pa.	4.3
L. S. Wood mine Mid-Continent Coal and Coke Co. Pitkin County, Colo.	3.5
Arkwright mine Consolidation Coal Co. Monongalia County, W. Va.	3.4
Dutch Creek mine Mid-Continent Coal and Coke Co. Pitkin County, Colo.	3.2
Virginia Pocahontas No. 2 mine Island Creek Coal Co. Buchanan County, Va.	3.1
Virginia Pocahontas No. 3 mine Island Creek Coal Co. Buchanan County, Va.	3.1
Shannopin mine Jones & Laughlin Steel Corp. Greene County, Pa.	2.9
Gateway mine Gateway Coal Co. Greene County, Pa.	2.6
Blacksville No. 2 mine Consolidation Coal Co. Monongalia County, W. Va.	2.5
No. 14 mine U.S. Steel Corp. McDowell County, W. Va.	2.5
No. 21 mine Old Ben Coal Co. Franklin County, Ill.	2.4
Marianna No. 58 mine Bethlehem Mines Corp. Washington County, Pa.	2.3
Olga mine Olga Coal Co. McDowell County, W. Va.	2.2

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Shannon Branch mine Allied Chemical Corp. McDowell County, W. Va.	2.1
No. 2 mine U.S. Steel Corp. McDowell County, W. Va.	2.1
Joanne mine Eastern Associated Coal Corp. Marion County, W. Va.	2.0
No. 24 mine Old Ben Coal Co. Franklin County, Ill.	2.0
Lucerne No. 6 mine Rochester and Pittsburgh Coal Co. (Helvetia Coal Co.) Indiana County, Pa.	2.0
Vesta No. 5 mine Jones & Laughlin Steel Corp. Washington County, Pa.	1.9
Cambria Slope No. 33 mine Bethlehem Mines Corp. Cambria County, Pa.	1.9
Orient No. 3 mine Freeman Coal Mining Corp. Jefferson County, Ill.	1.9
Mathies mine Mathies Coal Co. Washington County, Pa.	1.8
Moss No. 2 mine Clinchfield Coal Co. Russell County, Va.	1.8
Ireland mine Consolidation Coal Co. Marshall County, W. Va.	1.8
Keystone No. 1 mine Eastern Associated Coal Corp. McDowell County, W. Va.	1.8

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
No. 26 mine Old Ben Coal Co. Franklin County, Ill.	1.8
Nelms No. 1 mine The Youghiogheny and Ohio Coal Co. Harrison County, Ohio	1.7
Howe No. 1 mine Howe Coal Co. Le Flore County, Okla.	1.6
Homer City mine North American Coal Co. (Helen Mining Co.) Indiana County, Pa.	1.6
Hampton No. 3 mine Westmoreland Coal Co. Boone County, W. Va.	1.6
Mulga mine Woodward Co., Division of Mead Corp. Jefferson County, Ala.	1.5
Somerset No. 60 mine Bethlehem Mines Corp. Washington County, Pa.	1.5
Forge Slope mine Glen Nan Coal Co. Luzerne County, Pa.	1.5
Moss No. 3 mine (portal A) Clinchfield Coal Co. Dickenson County, Va.	1.4
Consol No. 20 mine Consolidation Coal Co. Marion County, W. Va.	1.4
Nelms No. 2 mine Youghiogheny and Ohio Coal Co. Harrison County, Ohio	1.3
Valley Camp No. 3 mine Valley Camp Coal Co. Ohio County, W. Va.	1.3

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Pursglove mine Consolidation Coal Co. Monongalia County, W. Va.	1.3
No. 93 mine Consolidation Coal Co. Marion County, W. Va.	1.2
No. 1 Cedar Grove mine Boone County Coal Co. Logan County, W. Va.	1.2
Clyde mine Republic Steel Corp. Washington County, Pa.	1.2
Sunnyside No. 1 mine U.S. Steel Corp. Carbon County, Utah	1.2
Maple Creek mine U.S. Steel Corp. Washington County, Pa.	1.1
Bessie mine U.S. Pipe and Foundry Co. Jefferson County, Ala.	1.1
Montour No. 4 mine Consolidation Coal Co. Washington County, Pa.	1.1
Robinson Run No. 95 mine Consolidation Coal Co. Harrison County, W. Va.	1.1
Inland mine Inland Steel Co. Jefferson County, Ill.	1.1
Itmann No. 3 mine Itmann Coal Co. Wyoming County, W. Va.	1.0
Crown mine Freeman Coal Mining Corp. Montgomery County, Ill.	1.0

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Bishop mine Bishop Coal Co. McDowell County, W. Va.	1.0
East Gulf mine Winding Gulf Coals, Inc. Raleigh County, W. Va.	1.0
Nemacolin mine Buckeye Coal Co. Greene County, Pa.	1.0
Williams mine Consolidation Coal Co. Harrison County, W. Va.	1.0
Orient No. 6 mine Freeman Coal Mining Corp. Jefferson County, Ill.	1.0
Flat Top mine U.S. Pipe and Foundry Co. Jefferson County, Ala.	1.0
Maitland mine Consolidation Coal Co. McDowell County, W. Va.	.9
Kenilworth mine North American Coal Corp. Carbon County, Utah	.9
Newfield mine Republic Steel Corp. Allegheny County, Pa.	.8
Lancashire No. 20 mine Barnes & Tucker Co. Cambria County, Pa.	.8
Compass No. 2 mine Clinchfield Coal Co. Harrison County, W. Va.	.8
McElroy mine Consolidation Coal Co. Marshall County, W. Va.	.8

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Segco No. 1 mine Southern Electric Generating Co. Walker County, Ala.	0.8
Thunderbird mine Ayrshire Coal Co. Sullivan County, Ind.	.7
Powhatan No. 1 mine North American Coal Corp. Belmont County, Ohio	.7
Lambert Fork mine Clinchfield Coal Co. Buchanan County, Va.	.7
Lancashire No. 24 mine Barnes & Tucker Co. Indiana County, Pa.	.7
Somerset mine U.S. Steel Corp. Gunnison County, Colo.	.7
No. 10 mine Slab Fork Coal Co. Raleigh County, W. Va.	.7
Bird No. 2 mine Island Creek Coal Co. Somerset County, Pa.	.7
Renton mine Consolidation Coal Co. Allegheny County, Pa.	.7
Fies mine Island Creek Coal Co. Hopkins County, Ky.	.6
Moss No. 3, Portal C mine Clinchfield Coal Co. Dickenson County, Va.	.6
Orient No. 4 mine Freeman Coal Mining Corp. Williamson County, Ill.	.6

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Westland mine Pittsburgh Coal Co. Washington County, Pa.	0.6
Itmann No. 4 mine Itmann Coal Co. Wyoming County, W. Va.	.6
Murdock mine Moffat Coal Co. Douglas County, Ill.	.6
Rose Valley No. 6 mine Consolidation Coal Co. Harrison County, Ohio	.6
Mars No. 2 mine Clinchfield Coal Co. Harrison County, W. Va.	.5
Sewell No. 4 mine Sewell Coal Co. Nicholas County, W. Va.	.5
Banning No. 4 mine Republic Steel Corp. Westmoreland County, Pa.	.5
Kepler mine Consolidation Coal Co. Wyoming County, W. Va.	.5
Bird No. 3 mine Island Creek Coal Co. Cambria County, Pa.	.5
Marion mine Tunnelton Mining Co. Indiana County, Pa.	.5
Alexander mine Valley Camp Coal Co. Marshall County, W. Va.	.5
Jane Nos. 1 and 2 mines Rochester and Pittsburgh Coal Co. Armstrong County, Pa.	.5

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Zeigler No. 9 mine Zeigler Coal Co. Hopkins County, Ky.	0.5
No. 10 mine Peabody Coal Co. Christian County, Ill.	.5
Slab Fork No. 8 mine Slab Fork Coal Co. Raleigh County, W. Va.	.5
Zeigler No. 4 mine Bell and Zoller Coal Co. Williamson County, Ill.	.5
Siltix mine The New River Co. Fayette County, W. Va.	.5
Eccles No. 5 mine Westmoreland Coal Co. Raleigh County, W. Va.	.5
Lady Dunn No. 105 mine Cannelton Coal Co. Kanawha County, W. Va.	.5
Dotiki mine Webster County Coal Corp. Webster County, Ky.	.4
Jensie mine North American Coal Corp. Jefferson County, Ohio	.4
Orient No. 5 mine Freeman Coal Mining Corp. Franklin County, Ill.	.4
Chetopa mine Alabama By-Products Corp. Jefferson County, Ala.	.4
Hampton No. 4 mine Westmoreland Coal Co. Boone County, W. Va.	.4

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
No. 34 mine Carbon Fuel Co. Kanawha County, W. Va.	0.4
No. 1 mine Monterey Coal Co. Macoupin County, Ill.	.4
Keystone No. 2 mine Eastern Associated Coal Corp. Wyoming County, W. Va.	.4
Allen mine CF and I Steel Corp. Las Animas County, Colo.	.4
Sewell No. 1 mine Sewell Coal Co. Nicholas County, W. Va.	.4
Drake No. 1 mine Pittsburg & Midway Coal Mining Co. Muhlenberg County, Ky.	.4
East Diamond mine Island Creek Coal Co. Hopkins County, Ky.	.4
Segco No. 2 mine Southern Electric Generating Co. Shelby County, Ala.	.4
Dehue mine Youngstown Mines Corp. Logan County, W. Va.	.3
No. 3 mine Wolf Creek Collieries Co. Martin County, Ky.	.3
No. 44 mine Bethlehem Mines Corp. Marion County, W. Va.	.3
Warwick No. 2 mine Duquesne Light Co., Coal Dept. Greene County, Pa.	.3

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Badger No. 14 mine Badger Coal Co. Barbour County, W. Va.	0.3
Keystone No. 4 mine Eastern Associated Coal Corp. Raleigh County, W. Va.	.3
Eagle No. 2 mine Peabody Coal Co. Gallatin County, Ill.	.3
No. 25 mine National Coal Mining Co. Mingo County, W. Va.	.3
Prescott No. 1 mine Westmoreland Coal Co. Wise County, Va.	.3
Crescent mine Island Creek Coal Co. Muhlenberg County, Ky.	.3
Macalpin mine Westmoreland Coal Co. Raleigh County, W. Va.	.3
Bullitt No. 1 mine Westmoreland Coal Co. Wise County, Va.	.3
Choctaw Coal Facility mine Kerr-McGee Corp. Haskell County, Okla.	.3
Donegan No. 10 mine Island Creek Coal Co. Nicholas County, W. Va.	.3
Birch No. 1 mine Birch Coal Co. Nicholas County, W. Va.	.3

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Sunnyside No. 3 mine Kaiser Steel Corp. Carbon County, Utah	0.3
Warwick, Portal No. 3 mine Duquesne Light Co., Coal Dept. Greene County, Pa.	.3
Shoemaker mine Consolidation Coal Co. Marshall County, W. Va.	.3
No. 51 mine Bethlehem Mines Corp. Washington County, Pa.	.3
Scotia mine Scotia Coal Co. Letcher County, Ky.	.3
York Canyon No. 1 mine Kaiser Steel Corp. Colfax County, N. Mex.	.3
Dixianna mine Coal Processing Corp. West County, Va.	.3
No. 4-H mine Amherst Coal Co. Logan County, W. Va.	.2
Guyan No. 5 mine Island Creek Coal Co. Logan County, W. Va.	.2
Keystone No. 4-A mine Eastern Associated Coal Corp. Raleigh County, W. Va.	.2
No. 41 mine Bethlehem Mines Corp. Marion County, W. Va.	.2
Vail mine Island Creek Coal Co. Harrison County, Ohio	.2

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Maxine mine Alabama By-Products Corp. Jefferson County, Ala.	0.2
No. 77 mine Bethlehem Mines Corp. Cambria County, Pa.	.2
Guyan No. 1 mine Island Creek Coal Co. Logan County, W. Va.	.2
Powhatan No. 3 mine North American Coal Corp. Belmont County, Ohio	.2
Hutchinson mine Pittsburgh Coal Co. Westmoreland County, Pa.	.2
Nos. 3 and 4 mines Cannelton Coal Co. McDowell County, W. Va.	.2
Hillsboro mine Truax-Traer Coal Co. Montgomery County, Ill.	.2
Hamilton No. 1 mine Island Creek Coal Co. Union County, Ky.	.2
Lancashire No. 25 mine Barnes & Tucker Co. Cambria County, Pa.	.2
Kings mine Kings Station Coal Corp. Gibson County, Ind.	.2
Soldier Canyon mine Premium Coal Co. Carbon County, Utah	.2
No. 19 mine, Wanamie Colliery Blue Coal Corp. Luzerne County, Pa.	.2

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Pyro mine No. 2 Pyro Mining Co. Union County, Ky.	0.2
No. 8 mine Cannelton Coal Co. Kanawha County, W. Va.	.2
Harmar mine Harmar Coal Co. Allegheny County, Pa.	.2
No. 9 mine Island Creek Coal Co. Hopkins County, Ky.	.2
Ken mine No. 4 Peabody Coal Co. Ohio County, Ky.	.2
No. 2 mine Carbon Fuel Co. Carbon County, Utah	.2
Putnam mine Union Carbide Corp. Mason County, W. Va.	.2
No. 16 mine Sahara Coal Co., Inc. Saline County, Ill.	.2
Beech Bottom mine Windsor Power House Coal Co. Brooke County, W. Va.	.2
Powhatan No. 5 mine North American Coal Corp. Belmont County, Ohio	.2
Itmann No. 1 mine Itmann Coal Co. Wyoming County, W. Va.	.2
Camp No. 2 mine Peabody Coal Co. Union County, Ky.	.2

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Eagle No. 1 mine Peabody Coal Co. Gallatin County, Ill.	0.2
Oakmont mine Harmar Coal Co. Allegheny County, Pa.	.2
River Queen Underground No. 1 mine Peabody Coal Co. Muhlenberg County, Ky.	.2
Isabella mine National Mines Corp. Fayette County, Pa.	.1
Moss No. 3, Portal D mine Clinchfield Coal Co. Dickenson County, Va.	.1
No. 7 mine Pocahontas Fuel Co. McDowell County, W. Va.	.1
Winding Gulf No. 4 mine Westmoreland Coal Co. Raleigh County, W. Va.	.1
Bear mine Bear Coal Co. Gunnison County, Colo.	.1
Oak Park No. 7 mine Hanna Coal Co. Harrison County, Ohio	.1
Hurricane Creek mine Clinchfield Coal Co. Russell County, Va.	.1
Chaney Creek No. 2 mine Clinchfield Coal Co. Russell County, Va.	.1
Star Underground mine Peabody Coal Co. Muhlenberg County, Ky.	.1

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Hamilton No. 2 mine Island Creek Coal Co. Union County, Ky.	0.1
Skelton mine Westmoreland Coal Co. Raleigh County, W. Va.	.1
Providence No. 1 mine Island Creek Coal Co. Hopkins County, Ky.	.1
Gorgas mine No. 7, America Opening Alabama Power Co. Walker County, Ala.	.1
Vesta No. 4 mine Jones & Laughlin Steel Corp. Washington County, Pa.	.1
David mine Canterbury Coal Co. Armstrong County, Pa.	.1
Newhall No. 6 mine Consolidation Coal Co. McDowell County, W. Va.	.1
Nos. 33 and 37 mines Bishop Coal Co. McDowell County, W. Va.	.1
Conemaugh No. 1 mine North American Coal Corp. Indiana County, Pa.	.1
Prescott No. 2 mine Westmoreland Coal Co. Wise County, Va.	.1
Otsego mine Westmoreland Coal Co. Wyoming County, W. Va.	.1
Saginaw No. 1 mine Oglebay Norton Co. Belmont County, Ohio	.1

Mine, owner, and location of mine	Average methane emission per day, million cubic feet
Kopperston No. 1 mine Eastern Associated Coal Corp. Wyoming County, W. Va.	0.1
Gaston No.2 mine Slab Fork Coal Co. Wyoming County, W. Va.	.1
Spartan mine Bell and Zoller Coal Co. Randolph County, Ill.	.1
Florence No. 2 mine Florence Mining Co. Indiana County, Pa.	.1
Adrian mine Upshur Coals, Ltd. Upshur County, W. Va.	.1
Valley Camp No. 1 mine Valley Camp Coal Co. Brooke County, W. Va.	.1
No. 10 Wisconsin Steel Coal mines International Harvester Co. Harlan County, Ky.	.1
No. 5 mine Sahara Coal Co., Inc. Saline County, Ill.	.1
Total.....	227

APPENDIX 3.--METHANE EMISSION IN RELATION TO COUNTIES FROM MINES EMITTING AT LEAST 100,000 CUBIC FEET OF GAS PER DAY

State and mine	County	Average methane emission per day, million cubic feet
Alabama:		
Concord No. 1	Jefferson	6.1
Mulga	...do	1.5
Bessie	...do	1.1
Flat Top	...do	1.0
Chetopa	...do	.4
Maxine	...do	.2
Total	-	10.3
Segco No. 2	Shelby	.4
Segco No. 1	Walker	.8
Gorgas No. 7	...do	.1
Total	-	.9
Colorado:		
Somerset	Gunnison	.7
Bear	...do	.1
Total	-	.8
Allen	Las Animas	.4
L. S. Wood	Pitkin	3.5
Dutch Creek	...do	3.2
Total	-	6.7
Illinois:		
No. 10	Christian	.5
Murdock	Douglas	.6
No. 21	Franklin	2.4
No. 24	...do	2.0
No. 26	...do	1.8
Orient No. 5	...do	.4
Total	-	6.6
Eagle No. 2	Gallatin	.3
Eagle No. 1	...do	.2
Total	-	.5
Orient No. 3	Jefferson	1.9
Inland	...do	1.1
Orient No. 6	...do	1.0
Total	-	4.0

State and mine	County	Average methane emission per day, million cubic feet
Illinois--Continued:		
No. 1	Macoupin	0.4
Crown	Montgomery	1.0
Hillsboro	do	.2
Total	-	1.2
Spartan	Randolph	.1
No. 16	Saline	.2
No. 5	do	.1
Total	-	.3
Orient No. 4	Williamson	.6
Zeigler No. 4	do	.5
Total	-	1.1
Indiana:		
Kings	Gibson	.2
Thunderbird	Sullivan	.7
Kentucky:		
No. 10 Wisconsin Steel Coal Mines	Harlan	.1
Fies	Hopkins	.6
Zeigler No. 9	do	.5
East Diamond	do	.4
No. 9	do	.2
Providence No. 1	do	.1
Total	-	1.8
Scotia	Letcher	.3
No. 3	Martin	.3
Crescent	Muhlenberg	.3
Drake No. 1	do	.4
Total	-	.7
River Queen Underground No. 1	do	.2
Star Underground	do	.1
Total	-	.3
Ken No. 4	Ohio	.2

State and mine	County	Average methane emission per day, million cubic feet
Kentucky--Continued:		
Dotiki	Union	0.4
Hamilton No. 1	...do	.2
Pyro No. 2	...do	.2
Camp No. 2	...do	.2
Hamilton No. 2	...do	.1
Total	-	1.1
New Mexico: York Canyon	Colfax	.3
Ohio:		
Powhatan No. 1	Belmont	.7
Powhatan No. 3	...do	.2
Powhatan No. 5	...do	.2
Saginaw No. 1	...do	.1
Total	-	1.2
Nelms No. 1	Harrison	1.7
Nelms No. 2	...do	1.3
Rose Valley No. 6	...do	.6
Vail	...do	.2
Oak Park No. 7	...do	.1
Total	-	3.9
Jensie	Jefferson	.4
Oklahoma:		
Choctaw Coal Facility	Haskell	.3
Howe No. 1	Le Flore	1.6
Pennsylvania:		
Newfield	Allegheny	.8
Renton	...do	.7
Harmar	...do	.2
Oakmont	...do	.2
Total	-	1.9
Jane Nos. 1 and 2	Armstrong	.5
David	...do	.1
Total	-	.6

State and mine	County	Average methane emission per day, million cubic feet
Pennsylvania--Continued:		
No. 32	Cambria	6.0
Cambria Slope No. 33	...do	1.9
Lancashire No. 20	...do	.8
Bird No. 3	...do	.5
No. 77	...do	.2
Lancashire No. 25	...do	.2
Total	-	9.6
Isabella	Fayette	.1
Robena	Greene	4.3
Shannopin	...do	2.9
Gateway	...do	2.6
Nemacolin	...do	1.0
Warwick No. 2	...do	.3
Warwick Portal No. 3	...do	.3
Total	-	11.4
Lucerne No. 6	Indiana	2.0
Homer City	...do	1.6
Lancashire No. 24	...do	.7
Marion	...do	.5
Conemaugh No. 1	...do	.1
Total	-	4.9
Forge Slope	Luzerne	1.5
No. 19 Wanamie Colliery	...do	.2
Total	-	1.7
Bird No. 2	Somerset	.7
Marianna No. 58	Washington	2.3
Vesta No. 5	...do	1.9
Mathies	...do	1.8
Somerset No. 60	...do	1.5
Clyde	...do	1.2
Maple Creek	...do	1.1
Montour No. 4	...do	1.1
Westland	...do	.6
No. 51	...do	.3
Vesta No. 4	...do	.1
Total	-	11.9
Banning No. 4	Westmoreland	.5
Hutchinson	...do	.2
Florence No. 2	...do	.1
Total	-	.8

State and mine	County	Average methane emission per day, million cubic feet
Utah:		
Sunnyside No. 1	Carbon	1.2
Kenilworth	...do	.9
Sunnyside No. 3	...do	.3
Soldier Canyon	...do	.2
No. 2	...do	.2
Total	-	2.8
Virginia:		
Beatrice	Buchanan	8.4
Virginia Pocahontas No. 1	...do	6.3
Virginia Pocahontas No. 3	...do	3.1
Virginia Pocahontas No. 2	...do	3.1
Lambert Fork	...do	.7
Total	-	21.6
Moss No. 3, Portal A	Dickenson	1.4
Moss No. 3, Portal C	...do	.6
Moss No. 3, Portal D	...do	.1
Total	-	2.1
Moss No. 2	Russell	1.8
Hurricane Creek	...do	.1
Chaney Creek No. 2	...do	.1
Total	-	2.0
Prescott No. 1	Wise	.3
Bullitt mine No. 1	...do	.3
Dixianna	...do	.3
Prescott No. 2	...do	.1
Total	-	1.0
West Virginia:		
Badger No. 14	Barbour	.3
Hampton No. 3	Boone	1.6
Hampton No. 4	...do	.4
Total	-	2.0
Beech Bottom	Brooke	.2
Siltix	Fayette	.5

State and mine	County	Average methane emission per day, million cubic feet
West Virginia--Continued:		
Robinson Run No. 95	Harrison	1.1
Williams	...do	1.0
Compass No. 2	...do	.8
Mars No. 2	...do	.5
Total	-	3.4
Lady Dunn No. 105	Kanawha	.5
No. 34	...do	.4
No. 8	...do	.2
Total	-	1.1
No. 1 Cedar Grove	Logan	1.2
Dehue	...do	.3
Guyan No. 5	...do	.2
No. 4-H	...do	.2
Guyan No. 1	...do	.2
Total	-	2.1
Loveridge	Marion	12.2
Consol No. 9	...do	8.0
Federal No. 1	...do	5.1
Joanne	...do	2.0
Consol No. 20	...do	1.4
No. 93	...do	1.2
No. 44	...do	.3
No. 41	...do	.2
Total	-	30.4
Ireland	Marshall	1.8
McElroy	...do	.8
Alexander	...do	.5
Shoemaker	...do	.3
Total	-	3.4
Putnam	Mason	.2
No. 14	McDowell	2.5
Olga	...do	2.2
No. 2	...do	2.1
Shannon Branch	...do	2.1
Keystone No. 1	...do	1.8
Bishop	...do	1.0
Maitland	...do	.9
Nos. 3 and 4	...do	.2
No. 7	...do	.1
Newhall No. 6	...do	.1
No. 33-37	...do	.1
Total	-	13.1

State and mine	County	Average methane emission per day, million cubic feet
West Virginia--Continued:		
No. 25	Mingo	0.3
Humphrey	Monongalia	10.7
Federal No. 2	...do	8.1
Osage No. 3	...do	7.0
Blacksville No. 1	...do	6.0
Arkwright	...do	3.4
Blacksville No. 2	...do	2.5
Pursglove	...do	1.3
Total	-	39.0
Sewell No. 4	Nicholas	.5
Sewell No. 1	...do	.4
Birch No. 1	...do	.3
Donegan mine No. 10	...do	.3
Total	-	1.5
Valley Camp No. 3	Ohio	1.3
Valley Camp No. 1	...do	.1
Total	-	1.4
East Gulf	Raleigh	1.0
No. 10	...do	.7
Slab Fork No. 8	...do	.5
Eccles No. 5	...do	.5
Keystone No. 4	...do	.3
Macalpin No. 3	...do	.3
Keystone No. 4-A	...do	.2
Winding Gulf No. 4	...do	.1
Skelton	...do	.1
Total	-	3.7
Adrian	Upshur	.1
Itmann No. 3	Wyoming	1.0
Itmann No. 4	...do	.6
Kepler	...do	.5
Keystone No. 2	...do	.4
Itmann No. 1	...do	.2
Otsego	...do	.1
Kopperston mine No. 1	...do	.1
Gaston No. 2	...do	.1
Total	-	3.0

APPENDIX 4.--METHANE EMISSION FROM MINES IN COALBEDS EMITTING IN EXCESS OF 1 MILLION CUBIC FEET FROM EACH BED

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Pittsburgh.....	Loveridge mine Marion County, W. Va.	12.2
	Humphrey No. 7 mine Monongalia County, W. Va.	10.7
	Federal No. 2 mine Monongalia County, W. Va.	8.1
	Consol No. 9 mine Marion County, W. Va.	8.0
	Osage No. 3 mine Monongalia County, W. Va.	7.0
	Blacksville No. 1 mine Monongalia County, W. Va.	6.0
	Federal No. 1 mine Marion County, W. Va.	5.1
	Robena mine Greene County, Pa.	4.3
	Arkwright mine Monongalia County, W. Va.	3.4
	Shannopin mine Greene County, Pa.	2.9
	Gateway mine Greene County, Pa.	2.6
	Blacksville No. 2 mine Monongalia County, W. Va.	2.5
	Marianna No. 58 mine Washington County, W. Va.	2.3
	Joanne mine Marion County, W. Va.	2.0
	Vesta No. 5 mine Washington County, Pa.	1.9

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Pittsburgh--Continued	Mathies mine Washington County, Pa.	1.8
	Ireland mine Marshall County, W. Va.	1.8
	Somerset mine Washington County, Pa.	1.5
	Consol No. 20 mine Marion County, W. Va.	1.4
	Pursglove mine Monongalia County, W. Va.	1.3
	Valley Camp No. 3 mine Ohio County, W. Va.	1.3
	No. 93 mine Marion County, W. Va.	1.2
	Clyde mine Washington County, Pa.	1.2
	Maple Creek mine Washington County, Pa.	1.1
	Montour No. 4 mine Washington County, Pa.	1.1
	Robinson Run No. 95 mine Harrison County, W. Va.	1.1
	Nemacolin mine Greene County, Pa.	1.0
	Williams mine Harrison County, W. Va.	1.0
	Compass No. 2 mine Harrison County, W. Va.	.8
	McElroy mine Marshall County, W. Va.	.8
	Powhatan No. 1 mine Belmont County, Ohio	.7

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Pittsburgh--Continued	Westland mine Washington County, Pa.	0.6
	Mars No. 2 mine Harrison County, W. Va.	.5
	Banning No. 4 mine Westmoreland County, Pa.	.5
	Alexander mine Marshall County, W. Va.	.5
	Warwick No. 2 mine Greene County, Pa.	.3
	No. 44 mine Marion County, Pa.	.3
	No. 51 mine Washington County, Pa.	.3
	Shoemaker mine Marshall County, W. Va.	.3
	No. 41 mine Marion County, W. Va.	.2
	Beech Bottom mine Brooke County, W. Va.	.2
	Hutchinson mine Westmoreland County, Pa.	.2
	Powhatan No. 3 mine Belmont County, W. Va.	.2
	Powhatan No. 5 mine Belmont County, W. Va.	.2
	Putnam mine Mason County, W. Va.	.2
	Vesta No. 4 mine Washington County, Pa.	.1
	Isabella mine Fayette County, Pa.	.1
		102.8

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Pocahontas No. 3.....	Beatrice mine Buchanan County, Va.	8.4
	Virginia Pocahontas No. 1 mine Buchanan County, Va.	6.3
	Virginia Pocahontas No. 3 mine Buchanan County, Va.	3.1
	Virginia Pocahontas No. 2 mine Buchanan County, Va.	3.1
	No. 14 mine McDowell County, W. Va.	2.5
	Shannon Branch mine McDowell County, W. Va.	2.1
	Keystone No. 1 mine McDowell County, W. Va.	1.8
	Bishop mine McDowell County, W. Va.	1.0
	East Gulf mine Raleigh County, W. Va.	1.0
	Itmann No. 3 mine Wyoming County, W. Va.	1.0
	Maitland mine McDowell County, W. Va.	.9
	No. 10 mine Raleigh County, W. Va.	.7
	Kepler mine Wyoming County, W. Va.	.5
	Keystone No. 2 mine Wyoming County, W. Va.	.4
	Keystone No. 4 mine Raleigh County, W. Va.	.3
	Macalpin No. 3 mine Raleigh County, W. Va.	.3

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Pocahontas No.3--(Con.)	Nos. 3 and 4 mines McDowell County, W. Va.	0.2
	Itmann No. 1 mine Wyoming County, W. Va.	.2
	No. 7 mine McDowell County, W. Va.	.1
	Newhall No. 6 mine McDowell County, W. Va.	.1
	Otsego mine Wyoming County, W. Va.	.1
		34.1
Illinois Nos. 5 and 6 ..	No. 21 mine Franklin County, Ill.	2.4
	No. 24 mine Franklin County, Ill.	2.0
	Orient No. 3 mine Jefferson County, Ill.	1.9
	No. 26 mine Franklin County, Ill.	1.8
	Inland mine Franklin County, Ill.	1.1
	Crown mine Montgomery County, Ill.	1.0
	Orient No. 6 mine Jefferson County, Ill.	1.0
	Murdock mine Douglas County, Ill.	.6
	Orient No. 4 mine Williamson County, Ill.	.6
	No. 10 mine Christian County, Ill.	.5

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Illinois Nos. 5 and 6--Continued.	Zeigler No. 4 mine Williamson County, Ill.	0.5
	Orient No. 5 mine Franklin County, Ill.	.4
	No. 1 mine Macoupin County, Ill.	.4
	Eagle No. 2 mine Gallatin County, Ill.	.3
	Hillsboro mine Montgomery County, Ill.	.2
	Eagle No. 1 mine Gallatin County, Ill.	.2
	No. 16 mine Saline County, Ill.	.2
	Spartan mine Randolph County, Ill.	.1
	No. 5 mine Saline County, Ill.	.1
		15.3
Upper Kittanning and Lower Kittanning.	No. 32 mine Cambria County, Pa.	6.0
	Cambria Slope No. 33 mine Cambria County, Pa.	1.9
	Lancashire No. 20 mine Cambria County, Pa.	.8
	Lancashire No. 24 mine Indiana County, Pa.	.7
	Bird No. 2 mine Somerset County, Pa.	.7
	Bird No. 3 mine Cambria County, Pa.	.5

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Upper Kittanning and Lower Kittanning--Continued.	Badger No. 14 mine Barbour County, W. Va.	0.3
	Birch No. 1 mine Nicholas County, W. Va.	.3
	No. 77 mine Cambria County, Pa.	.2
	Conemaugh No. 1 mine Indiana County, Pa.	.1
		11.5
Pocahontas No. 4.....	Olga mine McDowell County, W. Va.	2.2
	No. 2 mine McDowell County, W. Va.	2.1
	Shannon Branch mine McDowell County, W. Va.	2.1
	Maitland mine McDowell County, W. Va.	.9
	Itmann No. 4 mine Wyoming County, W. Va.	.6
	Slab Fork No. 8 mine Raleigh County, W. Va.	.5
	Nos. 3 and 4 mines McDowell County, W. Va.	.2
	Keystone 4-A mine Raleigh County, W. Va.	.2
	Winding Gulf No. 4 mine Raleigh County, W. Va.	.1
		8.9
Pratt.....	Concord No. 1 mine Jefferson County, Ala.	6.1
	Mulga mine Jefferson County, Ala.	1.5
		7.6

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Basin "B".....	L. S. Wood mine Pitkin County, Colo.	3.5
	Dutch Creek mine Pitkin County, Colo.	3.2
	Somerset mine Gunnison County, Colo.	.7
		7.4
Tiller.....	Moss No. 2 mine Russell County, Va.	1.8
	Moss No. 3, Portal A mine Dickenson County, Va.	1.4
	Lambert Fork mine Buchanan County, Va.	.7
	Moss No. 3, Portal C mine Dickenson County, Va.	.6
	Moss No. 3, Portal D mine Dickenson County, Va.	.1
		4.6
Freeport.....	Lucerne No. 6 mine Indiana County, Pa.	2.0
	Homer City mine Indiana County, Pa.	1.6
	Newfield mine Allegheny County, Pa.	.8
	Renton mine Allegheny County, Pa.	.7
	Marion mine Indiana County, Pa.	.5
	Harmar mine Allegheny County, Pa.	.2
	Oakmont mine Allegheny County, Pa.	.2

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Freeport--Continued...	Adrian mine Upshur County, W. Va.	0.1
	David mine Armstrong County, Pa.	.1
	Florence No. 2 mine Indiana County, Pa.	.1
		6.3
Cedar Grove.....	Hampton No. 3 mine Boone County, W. Va.	1.6
	No. 1 Cedar Grove mine Logan County, W. Va.	1.2
	Hampton No. 4 mine Westmoreland County, W. Va.	.4
	No. 25 mine Mingo County, W. Va.	.3
	Guyan No. 5 mine Logan County, W. Va.	.2
	Guyan No. 1 mine Logan County, W. Va.	.2
		3.9
Kentucky Nos. 9 and 11.	Fies mine Hopkins County, Ky.	.6
	Zeigler No. 9 mine Hopkins County, Ky.	.5
	Dotiki mine Union County, Ky.	.4
	East Diamond mine Hopkins County, Ky.	.4
	Drake No. 1 mine Muhlenberg County, Ky.	.4
	Crescent mine Muhlenberg County, Ky.	.3

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Kentucky Nos. 9 and 11--Continued.	Hamilton No. 1 mine Union County, Ky.	0.2
	Ken mine No. 4 Ohio County, Ky.	.2
	Pyro No. 2 mine Union County, Ky.	.2
	No. 9 mine Hopkins County, Ky.	.2
	Camp No. 2 mine Union County, Ky.	.2
	River Queen Underground No. 1 mine Muhlenberg County, Ky.	.2
	Providence No. 1 mine Hopkins County, Ky.	.1
	Hamilton No. 2 mine Union County, Ky.	.1
	Star Underground mine Muhlenberg County, Ky.	.1
		4.1
Nos. 6 and 6A.....	Nelms No. 1 mine Harrison County, Ohio	1.7
	Nelms No. 2 mine Harrison County, Ohio	1.3
	Jensie mine Jefferson County, Ohio	.4
	Oak Park No. 7 mine Harrison County, Ohio	.1
		3.5
Mary Lee.....	Bessie mine Jefferson County, Ala.	1.1
	Flat Top mine Jefferson County, Ala.	1.0

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Mary Lee--Continued...	Segco No. 1 mine Walker County, Ala.	0.8
	Chetopa mine Jefferson County, Ala.	.4
		3.3
Freeport Nos. 2 and 6, and Lower Freeport.	Lancashire No. 24 mine Indiana County, Pa.	.7
	Rose Valley No. 6 mine Harrison County, Ohio	.6
	Jane No. 1 and No. 2 mines Armstrong County, Pa.	.5
	Lancashire No. 25 mine Cambria County, Pa.	.2
		2.0
Hartshorne and Lower Hartshorne.	Howe No. 1 mine Le Flore County, Okla.	1.6
	Choctaw Coal Facility mine Haskell County, Okla.	.3
		1.9
Sewell.....	Sewell No. 4 mine Nicholas County, W. Va.	.5
	Siltix mine Fayette County, W. Va.	.5
	Sewell No. 1 mine Nicholas County, W. Va.	.4
	Donegan No. 10 mine Nicholas County, W. Va.	.3
		1.7

Coalbed	Name and location of mine	Average methane emission per day, million cubic feet
Twin, Bottom Ross, Top and Bottom Red Ash.	Forge Slope mine Luzerne County, Pa.	1.5
	No. 19 Wanamie Colliery Luzerne County, Pa.	.2
		1.7
Indiana Nos. 5 and 6..	Thunderbird mine Sullivan County, Ind.	.7
	Kings mine Gibson County, Ind.	.2
		.9
Upper Sunnyside and Lower Sunnyside.	Sunnyside No. 1 mine Carbon County, Utah	1.2
	Sunnyside No. 3 mine Carbon County, Utah	.3
		1.5
No. 2 Gas (known also as Imboden).	Lady Dunn No. 105 mine Kanawha County, W. Va.	.5
	Scotia mine Letcher County, Ky.	.3
	No. 10 Wisconsin Steel Coal mines Harlan County, Ky.	.1
		.9

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